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CARTRIDGE MAKING—2

METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO. IN THE MANUFACTURE OF CENTER-FIRE CARTRIDGES

By DOUGLAS T. HAMILTON*

Few sportsmen not acquainted with the methods employed in the manufacture of cartridges realize the amount of care and accuracy necessary to their production. There are so many points to be taken into consideration that even to those familiar with the subject, it is in some cases a difficult task to design and manufacture a cartridge suitable for the high-powered rifle of the latest pattern. Considering the difficulties encountered, it is interesting to note how the Dominion Cartridge Co., Montreal, Canada, is mastering these problems.

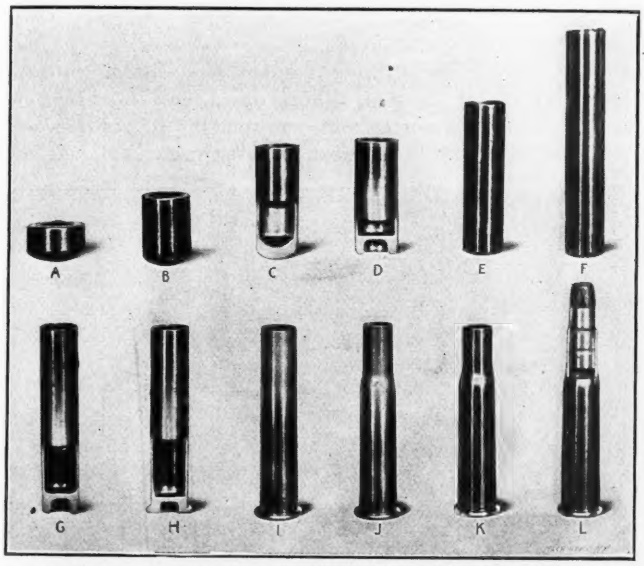


Fig. 19. Evolution from the Cup to the Finished Cartridge

Among the chief factors governing the accuracy with which a bullet strikes a target, may be mentioned: 1. The rifling in the barrel; 2. The nature and the amount of charge behind the missile; 3. The shape and equilibrium of the bullet. The rifling and the explosive charge behind the bullet have a direct effect on the velocity, and also govern the height of the trajectory curve. Theoretically, it is impossible for a body to travel through the air in a straight path, but with the high-powered rifles, considering a range of one hundred yards, the height of the trajectory curve at fifty yards is very slight. In the case of the cartridge to be described, the height of the trajectory curve at fifty yards is 1.280 inch. The shape of the bullet has not such a pronounced effect on its accuracy as has its equilibrium—that is to say, if a bullet does not balance properly on its axis, it is impossible for it to travel in an anywhere nearly a straight path. This is one of the problems a manufacturer of cartridges has to deal with, and is, in all probability, one of the most difficult to master.

Probably the most popular and the best-known high-powered sporting rifles using smokeless powders are the 0.30-30 Winchester, Marlin and Savage rifles. The bullet for the cartridges used in these rifles is made in three distinct patterns, *viz.*, the full metal-cased or hard-point, the part metal-cased or soft-point and the mushroom or hollow-point. The first-named of these is used more particularly for target practice, while the two latter types are used for hunting and sporting purposes in general. The soft-point bullet which weighs about 170 grains is the type most commonly used for hunting purposes. When fired, this bullet has a muzzle velocity of approximately 2000 feet per second—a rate of 23 miles per minute. This is the type of bullet which will be described in connection with the 0.30-30 Winchester smokeless cartridge in the following. In this article reference is made to Figs. 2, 3, 5, 9, 12, 14 and 16, which appeared in the previous installment, in the March issue.

* Associate Editor of MACHINERY.

Annealing and Washing the Cups—First and Second Drawing Operations

The case for the 0.30-30 cartridge is received in the form of a cup, as shown at *A* in Figs. 19 and 21. These cups are taken to the annealer, shown in Fig. 2, where they are annealed, washed and dried, as previously described. When dry, the cups are taken to the friction-dial drawing press shown in Fig. 20, where they are placed on the stationary table *A*, from which they are removed by means of a shaker to the revolving dial *B*. This drawing press is similar to that shown in Fig. 5, except that it is single-headed. After the cup has passed through two drawing operations, as shown at *B* and *C* in Figs. 19 and 21, it is ready for the inserting or indenting operation.

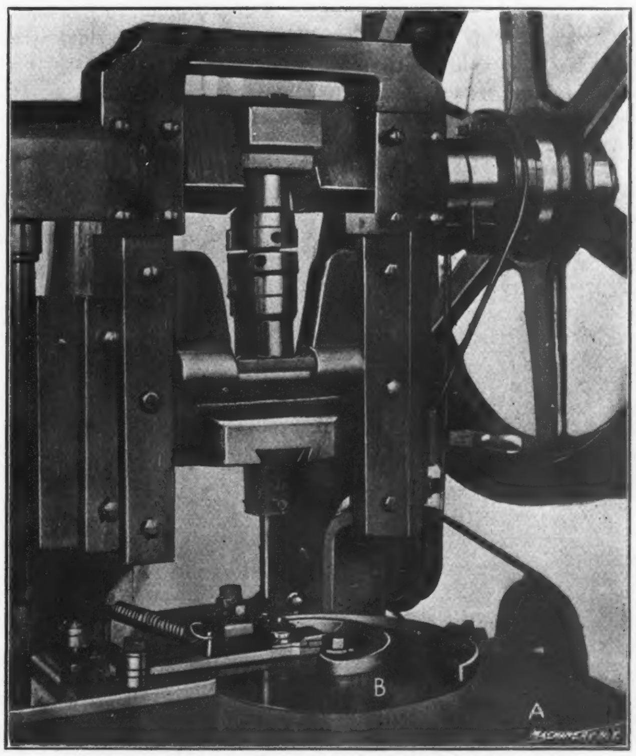


Fig. 20. Friction-dial Drawing Press for Drawing the Cups

Inserting—Rough Forming the Pocket for the Primer

The shell for the 0.30-30 Winchester cartridge is made with a solid head, which is not the case with cartridges of smaller size, in which, as a rule, smokeless powders are not used. The solid head is necessary to withstand the high pressure developed by smokeless powders. After the second drawing operation, the cup is not annealed, but is taken directly from the drawing presses to the headers, one of which is shown in Fig. 22. This header is used for inserting the pocket as well as forming the head. The principle on which this header works is similar to that of the horizontal header shown in Fig. 14, so we will turn our attention to the method used in rough forming the pocket. This is clearly shown at *A* in Fig. 24. As the shell comes down the slide of the header

shown in Fig. 22, it is located in a pocket, from which it is carried by the punch *a* (Fig. 24) into the die *b*. Here it is held by the punch while the inserting bunter advances and forms the pocket. Both punch and bunter then retreat, and on the forward stroke of the ram carrying the punch, the shell previously inserted is forced out of the die, as the punch carries another shell in.

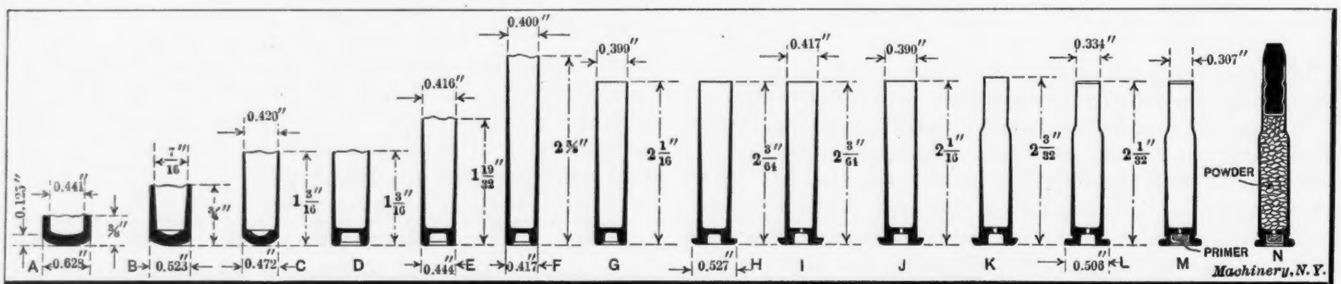


Fig. 21. The Various Operations on the Shell up to the Finished Cartridge

Third and Fourth Drawing Operations

The shell was not annealed after the second drawing operation, and it is necessary to do this before it can pass through the successive drawing operations. The shells are taken to the annealer, annealed, washed and dried, and brought back to the drawing presses. The shells are now of considerable length, and it is not advisable to perform the third and fourth drawing operations in the press shown in Fig. 20, as they would not stand up properly on the dial. For these operations, a ratchet-dial drawing press is used, the design of the dial of which is somewhat similar to the dial of the swaging machine shown in Fig. 34. After the third drawing operation the shells are again annealed, washed and dried, and then given a fourth drawing operation, which increases their length as shown at *F* in Fig. 21.

Trimming the Shells to Length

As shown at *F* in Fig. 21, the top edge of the shell is extremely ragged. Cracks develop in the mouth of the shell

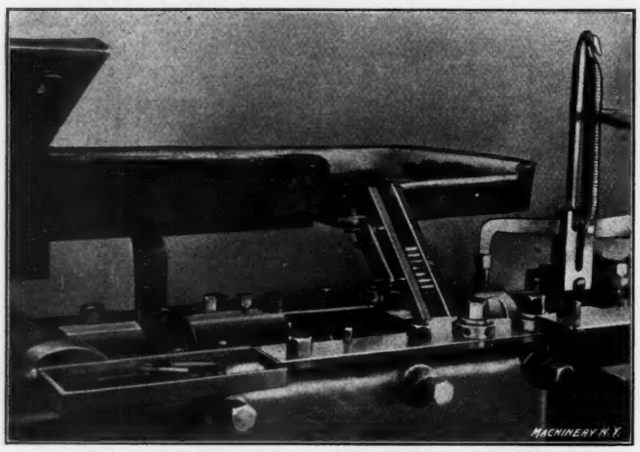


Fig. 22. Horizontal Header of the Semi-automatic Feed Type for Inserting the Cup and Forming the Head on the Shell

which makes it necessary to remove a certain amount to obtain a good finish. This is accomplished in the semi-automatic trimming machine shown in Fig. 23. Here the shells are placed in the slide *A* by the operator, from which they pass into a pocket at the base of the slide. From the pocket they are carried into the chuck by means of the punch *B* held in the punch head *C*, which is actuated by an eccentric crankshaft. The chuck begins to close before the punch reaches the limit of its travel, thus allowing the punch to insert the shell to the desired depth. The chuck is closed by means of a cam (not shown) at the rear of the machine, operating a clutch, which, in turn, forces a sleeve forward, thus closing the chuck. The tool-slide *D* carrying the trimming tool *E*, is now brought forward, and trims the shell to the desired length. As the trimming tool *E* advances, the punch *B* retreats from the shell. The chuck is now opened, and the punch advances carrying in another shell, which forces the previously trimmed one into a hollow sleeve. This hollow sleeve passes through the spindle of the machine, the trimmed shells dropping through it into a box placed beneath the machine. The pulley *F* drives the camshaft, which, in turn, operates the chuck closing, trimming and shell-inserting mechanisms. The machine is started by operating the lever *G*.

Forming the Head, Pocket Sizing and Piercing

The shell is now of the shape shown at *G* in Fig. 21, and is ready for the heading and stamping operation. It is again taken to the heading machine shown in Fig. 22, and operated on as shown diagrammatically at *B* in Fig. 24. As before, the shell is placed in the slide and drops down into the pocket, from which it is carried by the punch *d* into the die *e*. The heading bunter *f* now advances, finishing the pocket, and expanding the end of the shell to form the head. In this operation the punch does not retreat, but remains in position, supporting the shell, while the head is being completed. An end

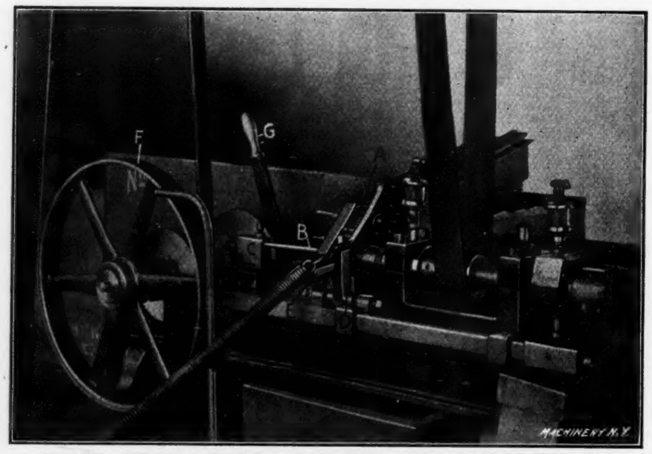


Fig. 23. Trimming Machine of the Semi-automatic Feed Type for Trimming the Shell to Length

view of the heading bunter is shown at *C*, and the shape of the shell after the heading operation is shown at *H*, Fig. 21.

There is considerable wear on the teat of the heading bunter in the heading operation, thus making it necessary to

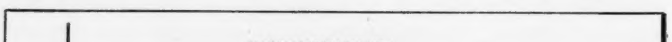


Fig. 24. Illustration showing how the Cup is inserted and the Shell headed

size the pocket so that the primer can be inserted without undue pressure. For this purpose, the shells are taken to a sizing machine of the ratchet-dial type, where they are placed on pins driven into this dial, and pass successively under a piercing, and a pocket-forming punch. The pierced shell is

not shown in Fig. 19, but may be seen at *I* in Fig. 21 where all the other operations on the shell are also more clearly shown.

Mouth Annealing

When the pocket has been sized and the hole pierced in the shell, thus making an opening so that the powder can be exploded by the discharge of the primer, the shells are taken to what is called a "mouth annealer." This machine, which is

Fig. 25. Friction-dial Mouth Annealer

shown in Fig. 25, anneals the shells for about two-thirds of their length. The shells are placed in a vertical position, resting on their heads on the revolving dial *A*, which is rotating in the direction of the arrow. They pass around on this dial between the guard *B* and the spring *C*. This spring is given a vibrating motion by the action of the revolving dial, thus agitating the shells and arranging them in single file, so that each shell will be exposed to the flame. As the shells are carried around on this dial they pass in front of two gas burners *D* and *E*, where the mouth of the shell is annealed. Gasoline is used as a fuel, being pumped into the burners at the desired pressure by a pump located at the right of the annealer, but which is not shown in the illustration. The speed at which this dial revolves is such, that the shells remain in front of the burners long enough to be sufficiently annealed. They are then removed from the dial by a wire *F* which pushes them off into a box, where they are allowed to cool gradually.

Reducing and Verifying

The reason for annealing the mouth of the shell is to make it soft, so that it can be reduced on the mouth without cracking or folding. Before the shells are reduced, they are oiled with a rag which has lard oil spread over it. They are then taken to the machine shown in Fig. 26, which is a reducing press of the ratchet-dial type. Here they are dumped into a box placed in front of the machine, from which they are removed by the operator and placed in the holes in the friction-dial *A*. This dial is driven by a finger *B*, which is held to a dovetailed slide *C*, the slide being actuated by the lever *F*, which is connected eccentrically to the crankshaft.

As can be seen in the illustration, the holes in the dial *A* are larger at the front end. The dial is made in this manner so that the heads can be inserted in the larger hole, and as the dial revolves, the friction between the head of the shell and the base of the machine draws the shell back into the smaller portion of the hole. When the shell is in this position, it cannot be removed by the reducing dies, should they stick to the shell. The friction between the head of the shell and the bed of the machine, however, cannot be relied upon to locate the shells properly, so a spring pad is placed in the bed of the press, over which the shells pass before reaching the first reducing die.

The ram of this machine is made to hold two reducing dies. The first boss *D* holds what is called the breaking-down die, which only passes down a certain distance over the mouth of the shell, while the second boss *E* holds the reducing die. This latter die travels down practically the whole length of the shell, and gives it a tapering shape. The action of reducing is more clearly shown in Fig. 29, where the dies are located in the relative positions that they occupy when in the machine. The breaking-down die is shown at *A* while the reducing die is shown at *B*. It is necessary in this operation to support the inside of the shell while reducing, and for this purpose punches *a* and *b* are inserted in the die, as shown, to prevent the shell from folding.

From the reducing machine the shells are transferred to the verifying machine shown in Fig. 27. Here they are placed by the operator in verifying dies, sixteen of which are held in the ratchet-dial *A* by spanner nuts *B*. This ratchet-dial *A* is actuated in the same manner as that of the reducing press. As the shells pass around, the punch *C* seats them in the verifying dies, and as they pass around still further, the punch *D* forces them down into the die until the under side of the head of the shell rests on top of it. As the ratchet-dial continues in its travel, a "knock-out" placed beneath the dial lifts the ejector pins, which forces the shell up out of the die to a sufficient height, so that the pick-up *E* can grip it.

As each shell is picked up, it forces the preceding one up through a brass tube from which it falls out at *F* into the chute *G*. This pick-up is operated by a lever *H* fulcrumed to the ram of the machine and pivoted to a bracket *I*, which is fastened to the uprights of the machine. The end of the

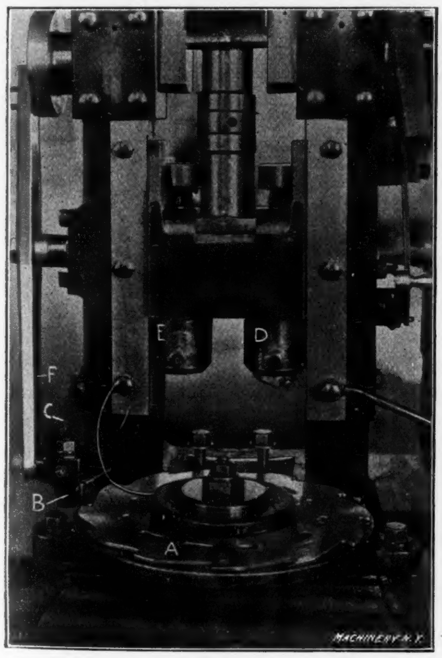


Fig. 26. Ratchet-dial Reducing Press for Reducing the Mouth of the Shell

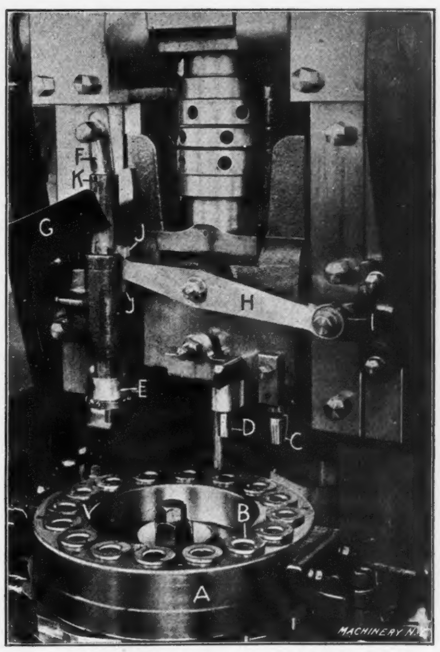


Fig. 27. Verifying Machine in which the Reducing of the Shell is completed

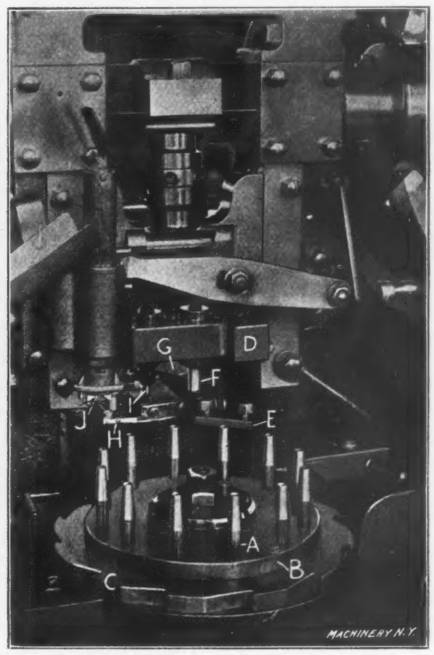


Fig. 28. Priming Machine for Inserting the Primer in the Pocket of the Shell

lever which operates the pick-up is rounded, so that it "rolls" freely between the projections J formed on the pick-up spindle K. This verifying operation reduces the shells on the mouth to the correct diameter, as shown at K, Fig. 21. Small pins or knock-outs are used to support the mouth of the shell while being reduced, acting on the same principle as those shown in Fig. 29.

Head Trimming, Mouth Trimming and Trimming to Length

After the shells have been verified they are removed to the washing-room, where they are put into the revolving tubs

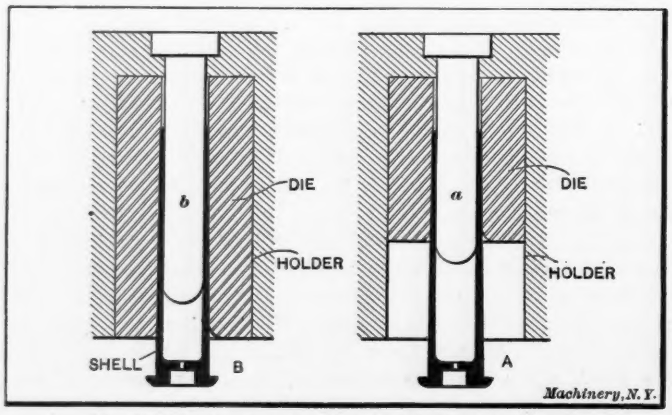


Fig. 29. Showing how the Mouth of the Shell is Reduced

shown in Fig. 3, washed, dried, and then brought to the trimming department. The operations now to be performed on the shell are trimming the head, trimming the shell to the proper length, and burring the mouth so that the bullet can be inserted easily. The trimming machine for performing these operations is shown in Fig. 31. The shells are placed in the slide A by the operator, from which they pass into a pocket B, the head of the shell facing the punch C, as shown. The drum D to which cams are attached actuates the slide E, carrying the punch C, which, in turn, forces the shell into the revolving chuck F. This chuck is made in two pieces, and

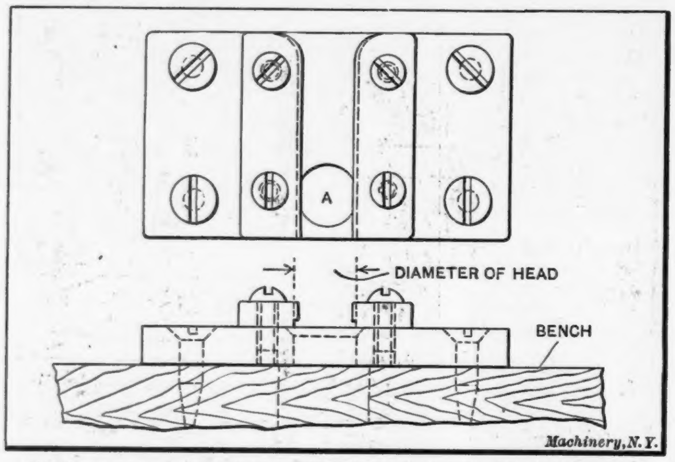


Fig. 30. Snap-gage used on the Bench for Gaging the Head of the Shell

is closed by split rings F_1, operated upon by a cam, attached to the main driving shaft beneath the machine. The chuck is rotated by a belt G, which runs on the pulley H.

Now that the shells are held in the chuck, a cam attached to the driving shaft carries a slide I forward, in which is held a trimming-tool holder J_1. Circular forming tools are held on this trimming-tool holder for trimming the head of the shell, giving it the appearance as at L, Fig. 21. A group of these circular tools may be seen hanging on the hopper at J to the left of the illustration. At the same time that the slide carrying the head-trimming tool is being advanced, the slide K also advances, carrying a trimming tool, which trims the shell to length. This trimming tool is similar to that previously shown in Fig. 16. As soon as the shell is trimmed to length, the mouth-trimming tool L advances and trims the mouth of the shell. This tool is made from ⅜-inch drill rod.

After the trimming operations are completed, the chuck is automatically opened, and the punch M advances carrying the shell out of the chuck, from which it drops into the chute N, and thence into a box O. The snap-gage used for gaging the head and length of the shell in this operation, is shown at P, hanging to the hopper. It is the ordinary type of combination snap- and ring-gage, and will not need description. Gage P is only used when setting up the machine, and testing at the beginning of each box of shells. After the shells come from this machine, they are deposited on a bench, where an operator passes them through a snap-gage shown in Fig. 30, which is attached to the bench. This gage is so constructed that it is impossible to pass a shell through the hole A and into the box, without first passing the head of the shell through the slide of the gage. If any shells are found to have large heads they are put to one side and again pass through the trimming operation, so that all shells that pass this inspection have heads of the correct diameter.

Inserting the Primers and Inspecting for High Primers

The shells are now transferred from the trimming department to the priming machines, one of which is shown in Fig. 28, where they are placed in hollow pins A, twelve of which are driven into a dial B, fastened to a ratchet-dial C. This ratchet-dial is driven in a similar manner to the other ratchet-dials previously described. As the operator places the shells

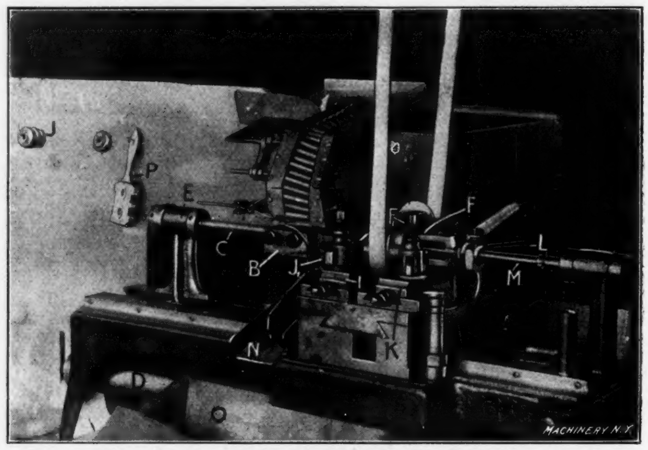


Fig. 31. Trimming Machine for Trimming the Head and Mouth, and for Trimming the Shell to the Desired Length

in the hollow pins A, they pass around under a punch (not shown) which is held in the boss D. This acts as an emergency punch to insure that all the shells have been pierced. A plate E acts as a guard to prevent the emergency punch from pulling the shells off the pins. However, this plate E is not relied upon exclusively, a punch F which is held in the ram of the press being used for seating the shells properly in the hollow pins.

The primers are shaken into small vulcanite plates, from which they are transferred to the table G, located at the rear of the machine. A friction-dial which is operated by a round belt driven from the main crankshaft, rotates just in front of this table. The operator now shoves the primers from the table onto the friction dial, which carries them around between two guards. This action of feeding the primers is

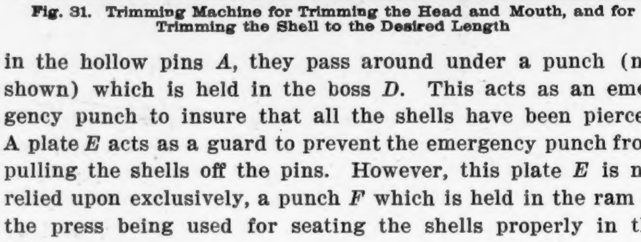


Fig. 32. Operations performed on the Lead Filling before and after Assembling in the Metal Case

similar to the action of the friction-dial drawing press, shown in Fig. 20. A finger H held on a slide carries one primer at a time out from the dial, and holds it central with the pocket in the shell. The punch I now descends, and carries the primer out of the finger, seating it in the pocket. As the dial passes around still further, the pick-up J descends, lifting the shells from the pins, and transfers them to a box in a similar manner to that shown in Fig. 27.

As can be seen in the illustration, the pins *A* are tapered so that the pick-up jaws can pass down over the head and get a good grip on the shell. The reason for using hollow pins instead of the ordinary solid pins for this operation is that the mouth of the shell is considerably smaller than the upper part of the body. This makes it necessary to put the shells in hollow pins, so that they will not be able to "wobble" when the primer is being inserted, as would be the case if solid pins were used. After the primers have been inserted in the pockets of the shells, they are transferred to a bench where an operator, by means of a small straightedge which is rubbed across the top of the shell, tests the primers to see whether any project above the face of the head. If a primer projects, a bright spot is noticed, so that this primer has to be knocked out and another one inserted.

Casting, Tumbling and Swaging the Slugs

The shell is now completed, so we will next take up the making of the bullet. The bullet which will be described in this article is called the "soft-point," and consists of a lead center which is partially enveloped by a metal case. The various stages through which this bullet passes are clearly shown in Fig. 32. *A* is the slug as it comes from the molds. These slugs are cast in molds of a similar design to those shown in Fig. 12, but of course, the forms in the molds are of the desired shape.

The slugs are removed from the molding department to a tumbling barrel, where they are tumbled for a considerable length of time to remove the fins; then they are dumped into the hopper of an automatic swaging machine, similar to that shown in Fig. 9, and come out in the form shown at *B*, Fig. 32. This finishes the operation on the lead center.

Drawing and Trimming the Metal Case

The metal case which is shown assembled on the lead center at *C*, *D* and *E* in Fig. 32, is made from copper and is nickel-plated after it has been trimmed to the desired length. This case for the bullet comes in the form of a cup and passes through three drawing operations, and the annealing, washing and drying operations, as was previously described regarding the shell for the 0.22 long. The same class of machines is also used for the various operations on this case.

When the case is completed, that is, after the drawing and trimming operations are performed, the case and the lead centers are transferred to the loading department. Here the lead centers are shaken into one plate while the copper cases are shaken into another. These plates are now assembled over each other, the plate holding the shells being on top, and a slip-plate is put under them. The three plates are then placed in the loading machine, Fig. 33. Seating punches *A* are held to the ram of this machine and as the lever *B* is pulled down, the ram descends, and the seating punches force the shells out of the plate *C* over the lead centers held in the plate *D*. These seating punches are made so that they pass into the holes in the shell plate.

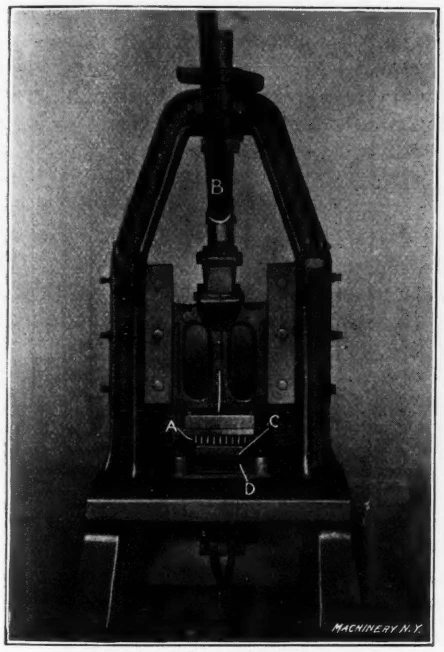


Fig. 33. Hand Loading Machine for Loading the Cartridge

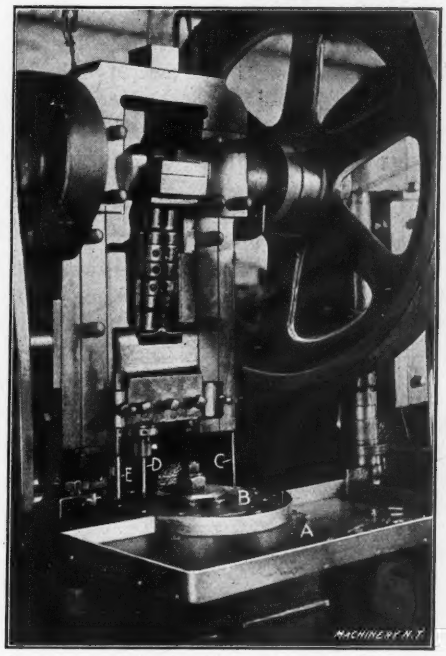


Fig. 34. Swaging Machine for forming the Lead Filling and the Metal Case to the Desired Shape

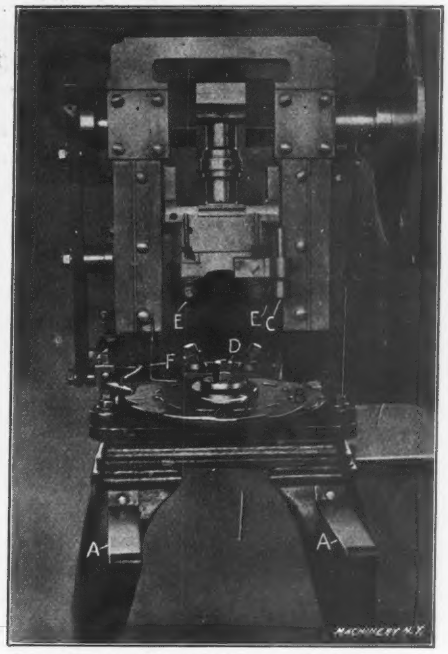


Fig. 35. Crimping Machine for Tightening the Cartridge Case on the Bullet after Loading

The bullet plate or "center holder" is made to give the bullet a shape such as shown at *C*, Fig. 32. The bullets as now formed are again transferred to the swaging department, where the operator places them on the table *A* of the machine shown in Fig. 34, from which they are put on the ratchet-dial *B*, the lead point extending downward. As the dial passes around, the punch *C* seats the bullet properly in it, and as it continues in its rotary movement, the punch *D* forces the bullet out of the dial into a die. This die gives the bullet the shape shown at *D*, Fig. 32, and also makes it symmetrical, so that it will balance properly on its axis. It might here be mentioned that the finishing of the bullet in one die insures this result.

As the ram of the press ascends, it carries upward two rods connected to the knock-out motion under the press, which, in turn, force a punch up through the die, the action of which again transfers the bullet from the die to the dial *B*. Just as the bullet is located in the dial, the latter is revolved and the punch *E* forces the bullet out of the dial into a chute, from which it is deposited into a box.

The next operation on the bullet is the forming of the knurled grooves shown at *E*, Fig. 32. The knurling of these grooves is accomplished in the canneluring machine shown in Fig. 36. The bullets are dumped on the dial *A*, from which they are removed by the operator and placed in a vertical position on the revolving dial *B*. Attached to the revolving dial *B* is a dial *C*, which has two knurled projections on its periphery. Back of dial *C* is a stationary segment *D*, which also has two knurled projections on its face.

In operation, as the bullets pass around on the dial *B* in the direction of the arrow, they are rotated by the action of the dial *C* revolving against the stationary segment *D*. This action forms the knurled grooves entirely around their peripheries. As the dial carries the bullets around still further, they are removed from it by means of a guide *E*, and drop into a box placed under the machine. The object of this canneluring operation is to form a groove in the bullet so that the top of the shell can be turned in, thus holding the bullet more securely in the shell. After the canneluring operation, the bullets are taken to the swaging machine shown in Fig. 34, and again pass through the operation of swaging, the same die being used as before. This is to correct any eccentricity of the bullet which might have been caused by canneluring.

Loading and Crimping

The shell and bullet are now ready for assembling or loading, and are transferred to one of the explosive departments where this operation is accomplished. In operation, the shells are taken into one plate and the bullets into another. Then the desired amount of powder is shaken into a charger, which is located over the shell plate and rapped slightly, thus depositing the powder in the shells. The shell plate containing the shells, and the bullet plate are removed to the loading machine shown in Fig. 33. Here the shell plate is put into

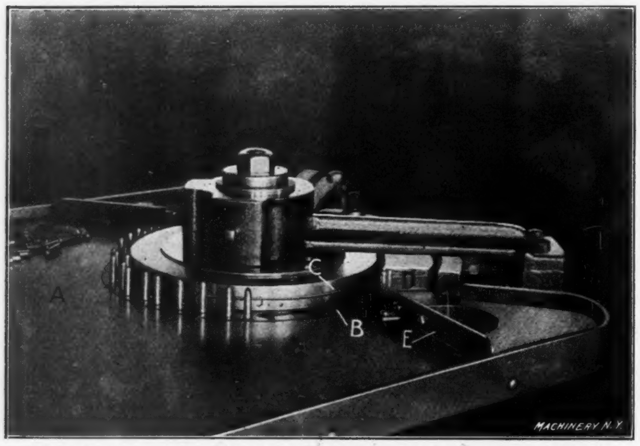


Fig. 36. Canneluring Machine for Forming the Grooves in the Bullet

the slide, the bullet plate located on top of it by means of dowels, and the handle *B* pulled down, carrying down the ram of the press to which the seating punches are fastened. These seating punches force the bullets out of the bullet plate and locate them in the shells. The plates are then removed and the loaded cartridges dumped out. The plates shown in the illustration, however, are not those used in this operation.

The loaded cartridges are now transferred to the crimping machine, Fig. 35, in which the top of the shell is tightened around the bullet. The operator dumps the cartridges into a box, which is held on the brackets *A* in front of the machine. He then removes the cartridges from the box and places them in the holes in the dial *B*. This dial rotates to the left, and as the cartridges come below the punch *C*, the bullet is seated in the shell to the correct depth. It will be noticed in the illustration that two bosses *E* are provided on the ram of this machine. Both bosses, however, are not used for crimping, as this machine is also used as a reducing press, when both bosses are necessary. The crimping die can be held in either boss, but is held preferably in the one to the left. This die is made so that it passes over the bullet and turns the shell in the groove, thus tightening the shell securely on the bullet. As the shells pass around still further, they are removed from the dial by the wire *F* and are deposited in a box under the machine. Spring pads are also used under this dial, the purpose of which was explained in the preceding in connection with the reducing press shown in Fig. 26.

Testing and Packing

The cartridges are now finished as regards the manufacturing operations, but they are not ready for the market until they pass through a rigid inspection. This inspection consists in testing for accuracy, velocity and penetration.

The accuracy of the cartridge is tested by means of shooting the bullets at various ranges for which the cartridges are adapted. This is done both by off-hand shooting, and also by locating the rifle in stocks, sighting it directly over the bull's-eye, firing it, and then noting the results.

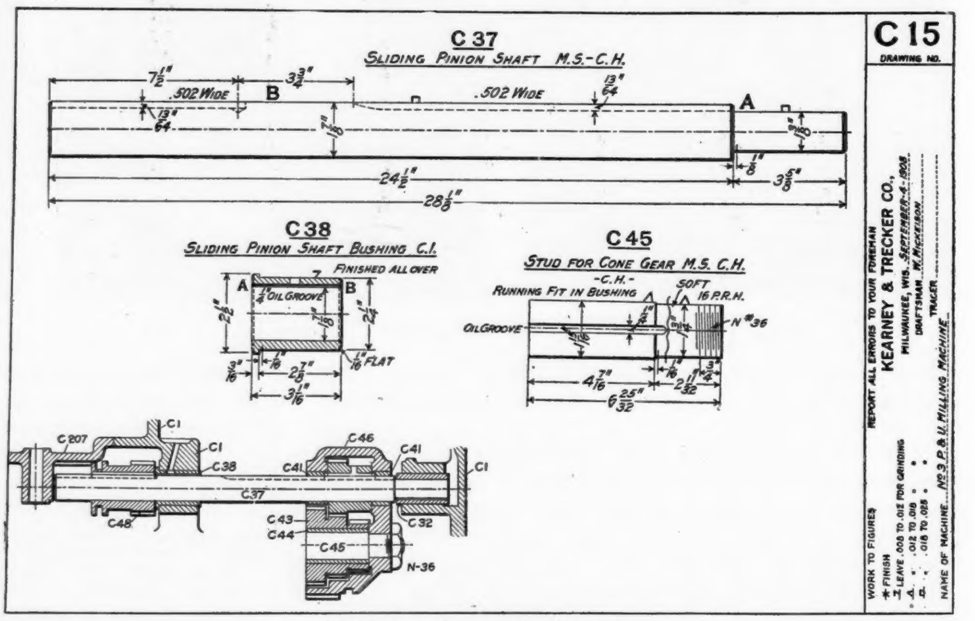
The velocity of the cartridge is determined by means of an instrument called the chronograph. This is an electrical instrument which operates in the following manner: The recording mechanism is connected with a wire, which is held just in front of the muzzle of the gun from which the cartridge is to be fired. Another wire is placed in front of the target and connected to the chronograph by an electrical circuit. When the apparatus is adjusted, a signal is given for the cartridge to be fired. As the bullet leaves the muzzle of the gun, it cuts the first wire which is connected to the chronograph, and the latter commences to record the flight of the bullet. When the bullet strikes the target, it breaks the electric circuit connected with the chronograph, and the instrument instantly stops registering. The recording apparatus shows the time taken by the bullet in traveling from the gun to the target, and as this distance is always known, it is an easy matter to determine the velocity in feet per second. The velocity of the 0.30-30 cartridge was previously given.

This cartridge is tested for penetration by shooting the bullets into boards of a given thickness. Pine boards, 7/8-inch thick, are, as a rule, used for this purpose. The penetration of the 0.30-30 soft-nose bullet, which is described in this article, is eleven boards, at a distance of 15 feet. If the cartridge does not pass this inspection satisfactorily, the cause is ascertained and rectified before any are shipped. These cartridges are packed by hand in boxes which hold 25. The boxes are then put in cases holding 5000 cartridges.

* * *

KEARNEY & TRECKER CO.'S DETAIL DRAWING PRACTICE

The illustration is a reproduction of a detail sheet which is an example of the drafting practice of the Kearney & Trecker Co., Milwaukee, Wis. A shaft and two studs are detailed in



A Kearney & Trecker Detail Drawing

the usual manner, and the location of the three parts when assembled is shown on the same sheet. The drawing is typical, the location of every detail part being shown in this manner. The advantage of this practice in the shop is obvious; it shows the workman how the parts on a shaft must be assembled and where the assembled unit goes. The sheet also shows certain finish convention marks used to designate the allowance for grinding.

* * *

One advantage of aluminum over copper for electric wires is that the "oily" surface of aluminum, due to the coating of the metal by hydroxide, causes it to shed water better than copper, so that aluminum wires are less likely to be coated with sleet even when they are larger in diameter than copper wires.

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—1

By S. N. BACON

The assembling of parts in the automatic screw machines is a practice which is not widely followed as yet, and the writer has only witnessed such jobs in shops where contract work was being done. In this article light assembling operations are described, and the attempt is made to prove that up-to-date methods are really worth while. The examples given include not only the assembling operations themselves, but also the making of the parts to be assembled from the same bar at the same chucking. This not only decreases the cost of making the parts, but also eliminates the necessity of handling them a second time.

In Fig. 1 is shown a small brass bolt and nut which a jobbing shop had been making for several years, each part being made on a separate machine. The assembling was done by hand, and consisted of screwing the nuts on the bolts. These parts are now made in a No. 0 Brown & Sharpe automatic screw machine at the same chucking, and assembled without rehandling.

The most interesting feature of the present method is the revolving of the turret twelve times during one revolution of the cams, that is, the turret makes two complete revolutions while the cams make one; the necessity for this will be explained later. The machine spindle is reversed three times. The additional revolving of the turret and reversing of the spindle are accomplished by the use of extra tripping dogs.

The method of applying the circular tools and the assembling tool is shown in Fig. 2. *A* is the form tool which forms the body of the bolt and cuts off the nut, and *B* is the tool which cuts off the bolt. This latter tool is mounted on the front cross-slide. This layout requires but one feeding of the stock for both pieces. The turret tool shown in Fig. 2, which is a carrier for the nut, comes forward just before the nut is cut off, and the spring chuck *C* closes over it. (The stock at this point is running backward.) The clutch finger *D* allows the carrier *C* to revolve in the holder *E*, thus preventing the nut from turning in the spring chuck and wearing off the corners. When the nut is inserted in the chuck *C*, and has been cut off, the spindle is reversed to run forward, the clutch finger preventing the carrier from turning. This clutch also acts while the nut is being screwed on the bolt. The clutch is more clearly shown in the sectional view to the right. The order of operations is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	18	3
Revolve turret	18	3
Drill 0.178-inch rise at 0.0034-inch feed	53	9
Revolve turret	18	3
Tap in	12	2
Tap out	12	2
Cut off 0.145-inch rise at 0.0017-inch feed	83	14
Revolve turret twice and bring carrier forward	(36)	(6)
Form with tool on rear-slide 0.130-inch rise at 0.00085-inch feed	159	27
Back away form tool to clear threading die	12	2
Revolve turret five times	(90)	(15)
Thread on	17	3
Thread off	17	3
Revolve turret	17	3
Thread on nut	12	2
Reverse spindle and withdraw turret	12	2
Cut off bolt 0.237-inch rise at 0.0019-inch feed	124	21
Revolve turret twice	(36)	(6)
Clearance	6	1
Total revolutions	590	100

With a spindle speed of 1474 revolutions per minute this layout gives a gross production of 1500 pieces in 10 hours, or 1350 pieces net. The time required to make and assemble both pieces is 24 seconds.

After the stock is fed out to a length sufficient to make both pieces, the end is drilled and tapped for the nut, which is then inserted in the carrier and cut off. The problem which now arises is to revolve the turret a sufficient number of times to bring the carrier into position to screw the nut on the finished bolt, as soon as the latter has been threaded. This is successfully accomplished by revolving the turret twice while cutting off the nut, and five times while forming the bolt.

The most interesting part of the job is the laying out of the cams. The usual set of three cams is shown in Fig. 3, the outline of the lead cam being shown as a solid line. It will be noticed that the lobe for centering is omitted from the lead cam. This is done because of the shallow depth of the hole to be drilled, and also because the work is not required to be very accurate.

The lobe which operates the carrier when gripping the nut is shown from 28 to 36 on the lead cam. Careful calculations

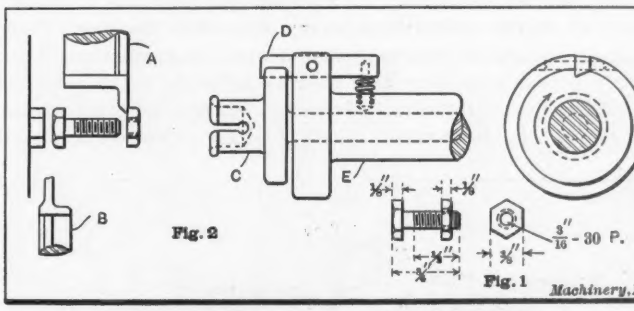


Fig. 1. Nut and Bolt to be made and assembled. Fig. 2. Method of Applying the Circular Tools and Construction of the Carrier or Assembling Tool

are necessary to determine the exact position of this lobe, so that the carrier will grip the nut before it is cut off. The method used to determine the position of this lobe is as follows: During the time from 22 to 28, which is equal to 36 revolutions of the spindle, the cut-off tool has advanced at the rate of 0.0019 inch per revolution, or $36 \times 0.0019 = 0.0684$ inch. The diameter of the stock across the corners is 0.432 inch, and the diameter of the drilled hole is 0.125 inch. Then the thickness of the wall on each side of the hole when the carrier advances on the work

$$= \frac{0.432 - (0.0684 \times 2) - 0.125}{2} = 0.085$$

inch, which is great enough to prevent the nut from breaking off when the carrier closes over it.

The hook shaped lobe from 74 to 76, threads the nut on the bolt, and the sudden drop pulls the carrier off the nut.

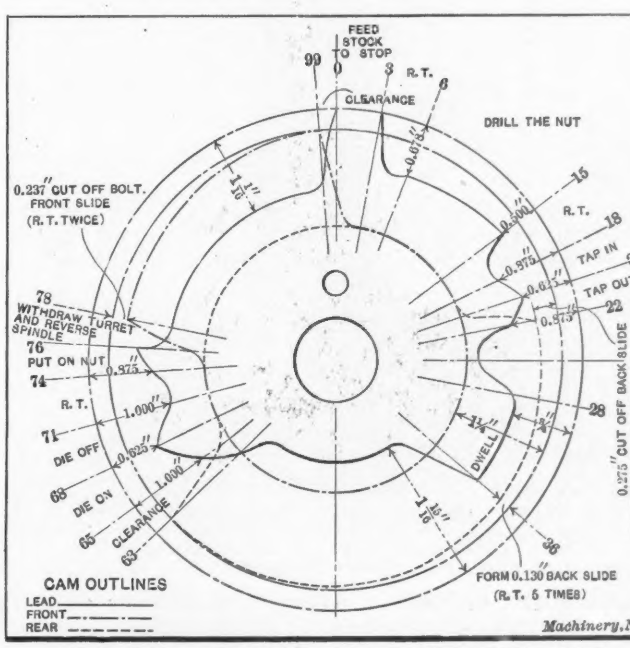


Fig. 3. Cams used for Making and Assembling the Nut and Bolt

The spindle is then reversed, so that it will be rotating in the correct direction to cut off the finished piece. The portion of the cam surfaces from 99 to 0 allows the cut-off tool to drop back and clear the stock before it is fed out for the next piece.

* * *

One of the best-known scientific authorities on aerial navigation in France, M. Soreau, has estimated that there is one fatal accident in aerial flights for each 4500 miles covered.

EQUIPMENT FOR ENGRAVING PEARL REVOLVER HANDLES

The mother-of-pearl used for handles of fine knives, revolvers, etc., is the hard iridescent lining of pearl oyster or river mussel shells. It is a calcareous concretion in irregular layers of nacre or nacreous substance, capable of taking and retaining a polish with luster and iridescence unequalled by any other common material. Although pearl is hard and brittle, it is cut with little difficulty by tools properly hardened and tempered, and is readily machined to any required shape; but the peculiarity of its stratified structure prevents the shaping of the exterior of handles to a prescribed form, as is always done, of course, with wood, ebony and bone handles. Pearl must be shaped by following the natural cleavage lines if the highly prized iridescent and lustrous effect is to be secured. The necessity of following the natural shapes of pearl makes no two knife or revolver handles alike. The contour and

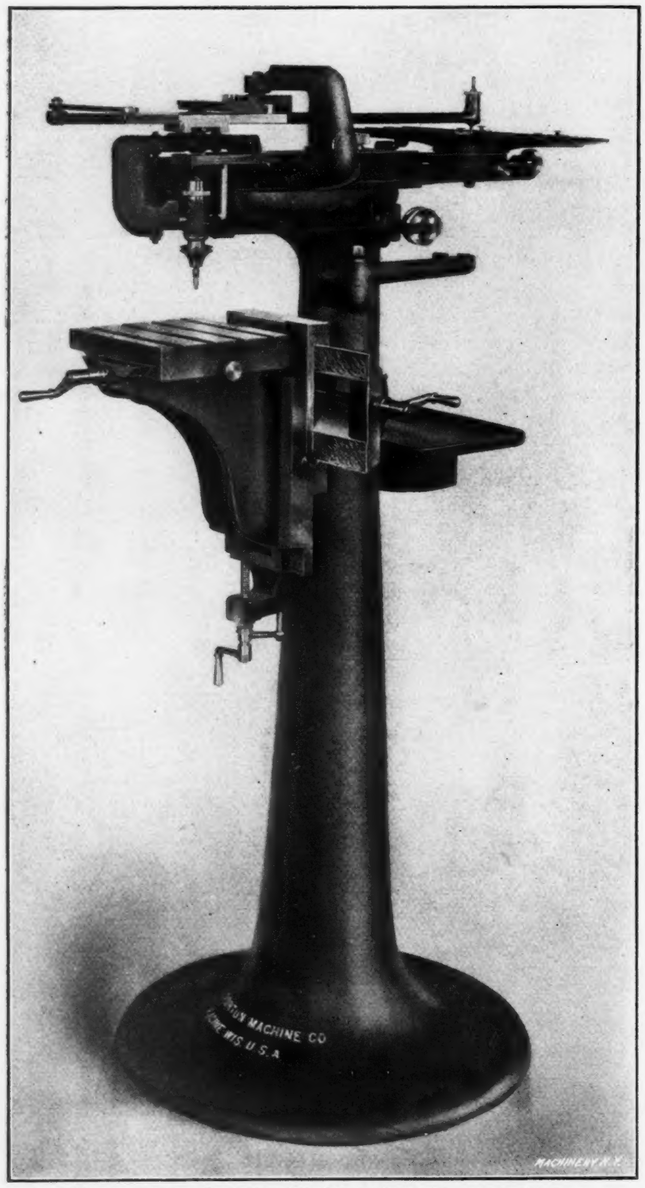


Fig. 1. Gorton Engraving Machine adapted to engraving on Rounded Surfaces

thickness of every pair of sides vary considerably and these variations make a pretty problem for the designer of the engraving machine to solve. The following description applies to the method developed by Messrs. George Gorton and Charles Rothweiler, of the Geo. Gorton Machine Co., Racine, Wis., for engraving pearl revolver handles on the Gorton engraving machine.

The Gorton engraving machine is of the vertical work-spindle pantograph type, the revolving cutter being guided laterally by "copy" several times the size of the desired reproduction. Fig. 1 shows the column-type of machine, No. 1 G, the knee and work spindle being in front and the copy table in the rear. The desired reduction is obtained by setting the pivot distances of the pantograph levers in the proper ratio. The work spindle is made to follow the form of the copy in reduced scale and the design is cut in the work by a flattened point V-shaped tool having one side cut away to the center the same as the half-center used for reaming lathe centers. The original design of the machine did not provide for guid-

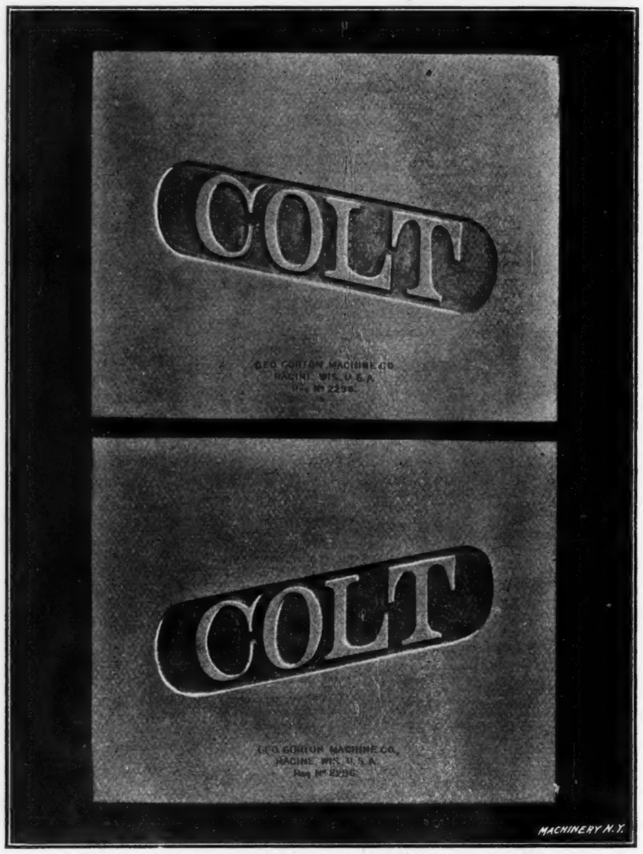


Fig. 2. Copy for Both Sides of Pearl Revolver Handles

ing the spindle vertically for depth, although adjustment, of course, was provided for setting the tool. In engraving curved surfaces, there must be means for varying the vertical position of the cutter to conform to the shape of the piece, if the depth of engraving is to be uniform. But as each half of a pearl revolver handle is of different shape and thickness,

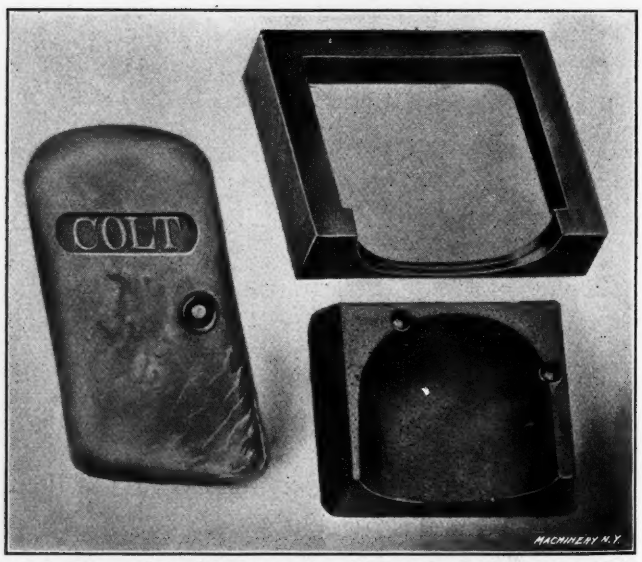


Fig. 3. Engraved Pearl Handle, Mold and Wax Former Produced in Mold

and no two are alike in a lot of a thousand, an individual former must be provided for every piece.

The formers are made of sealing wax, one at a time, in a mold containing the pearl handle to be engraved; and the wax former and pearl go to the engraving machine together. The pearl is mounted on a plate having three locating pins in the top side and two guides on the under side. The mold, made with tapered inner sides (see Fig. 3), is placed over the

pearl and plate and all are clamped in place as shown in Fig. 4. The melted wax is poured in the funnel-shaped opening and the plug at the right is used to expel the air bubbles and force the wax into close contact with the handle. When the wax has hardened, the handle *A* is pulled a quarter-turn to the right to cut off the sprue. The hole in the funnel is made eccentric, as will be seen in Fig. 6, to accomplish this action. This view shows the leaf of the mold jig raised to permit removal of the mold and wax former. The sprue is broken off

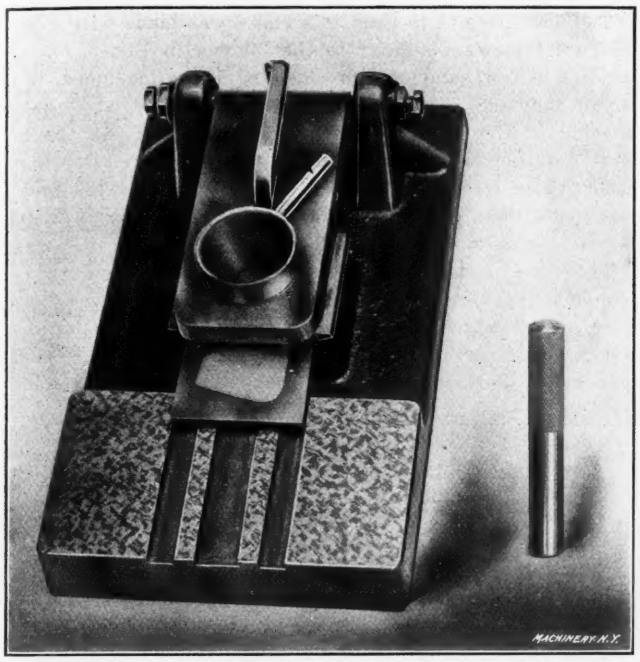


Fig. 4. Jig for Molding Wax Formers for Engraving Pearl Handles

below the level of the top surface, and no after trimming is necessary.

In Fig. 5 is shown the jig used on the engraving machine for holding the pearl handle. The handle is mounted on a plate—a duplicate of that on which it is mounted when the wax mold is made. The wax former is used on the machine directly over the spindle, where it is fixed in a dovetail groove holder, the same as the convex former shown in Fig. 1. The

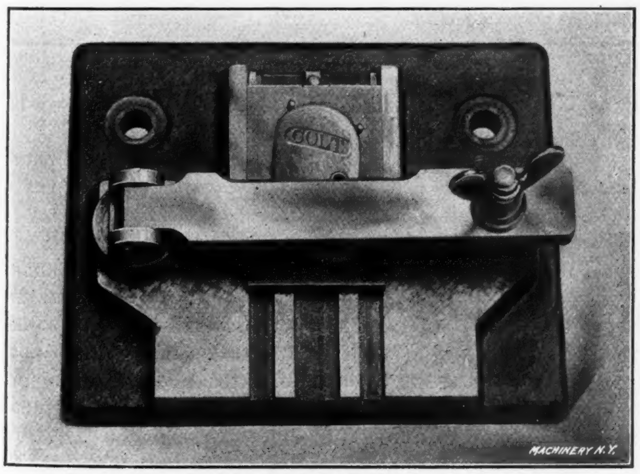


Fig. 5. Jig for Holding Pearl Handle for Engraving the Name

guide point on top of the spindle casing is held in contact with it by a spiral spring concealed in the side of the case.

The method of making the copy, Fig. 2, is simple but interesting. Manufacturers generally send an engraved sample to be duplicated. A rubbing taken off the sample on tracing paper is thrown on a screen with a projecting lantern to a scale, say, twenty times the size of the sample. The outline of the image is traced on a sheet of manila paper in pencil. The tracing is then tacked on the drawing-board and gone over to smooth up the lines, correct irregularities, distortions, etc. When the sketch has been corrected, it is cut out and mounted on a sheet of galvanized steel, using shellac both to mount it and to harden the edges of the paper, which is a guide for the pantograph tracing point. Several thicknesses of manila paper are used in order to get a thickness of about one-sixteenth inch. This makes the "first copy" that is used to generate the brass-plate copy shown. The first copy in the case of the engraving for the pearl handle is about five times the size of the finished copy in brass and this, in turn, is about four times the size of the engraving.

The actual engraving of a pearl handle does not differ materially from engraving the same design on a curved metal surface, except that care must be taken to prevent breaking away delicate points of the letters or tracery when the supporting material on the opposite side has been cut away. For instance, the slender sharp point of the "C" in the design must be traced with care to prevent slivering, on the finishing

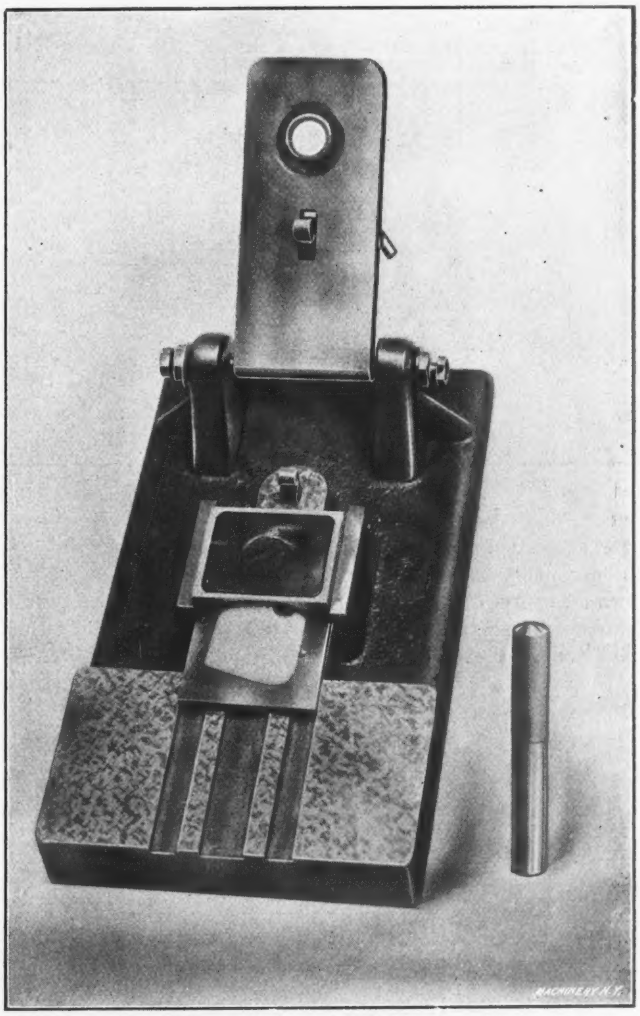


Fig. 6. Jig for Molding Wax Formers, with Leaf Turned back showing Eccentric Sprue Cutter, etc.

cut. The design should be traced if possible so that the cutter action is *toward* the body of the remaining material, thus insuring some support for the pearl in direct line with the push of the cut. F. E. R.

* * *

PATENTS AND PATENT PROTECTION

The patent laws of the United States were framed to encourage the arts and industries. Inventors were given monopoly rights in their inventions for the term of seventeen years, at the expiration of which anyone is free to make and market the device protected by the patent. Notwithstanding the broad intent of the patent law and the aim of its framers to encourage competitive manufacturing by giving inventors a monopoly in the beginning, a certain odium attaches to the making of machines on which patents have expired. Certain interests in a few well-known cases have fostered the belief that the young competitive concerns engaged in making the products developed by them, are little better than thieves and pirates. While we admire most the concerns that develop original ideas and design and push their own peculiar products, there certainly can be no blame attached to the makers of machines no longer protected by patents.

PUNCH AND DIE FOR BENDING A PERFORATED BLANK

By C. H. ROWE*

The writer was at one time called upon to consider the best method of bending the piece shown in Fig. 1. This at first glance appeared to be a simple operation, but upon trying it out, it was found that on account of the stock being so thick, and the web between the holes so narrow, it was a difficult proposition to prevent the webs from being distorted. The width of the rectangular holes was also increased.

The blanks were first cut to the required length in a power shear, and afterwards pierced in the die shown in Fig. 2, the stock, of course, being of the required width. The piercing die is made up of two sections *A*, which are held in a die-holder not shown. The dowels *D* were used for locating the two segments in the correct relation to each other. As it was thought impracticable to make the webs integral with the sections *A*, they were made from steel strips *C*, which were inserted as shown. All the parts of the die were carefully hardened and ground, after which they were assembled in a heavy cast-steel die-holder having a clearance hole cut in it a few thousandths of an inch larger than the holes in the die, to let the scrap drop through.

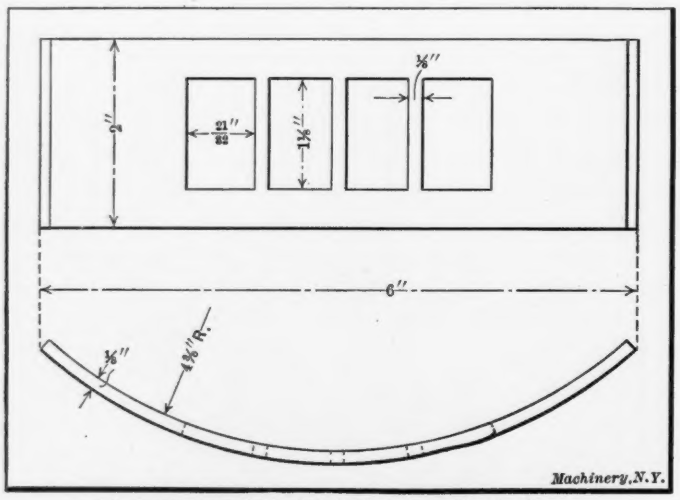


Fig. 1. Perforated Blank to be bent to a Circular Shape

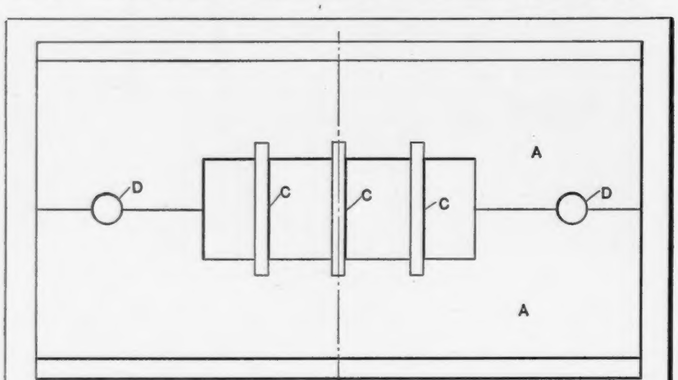


Fig. 2. Die for Piercing the Holes in the Blank

As is our usual practice when making dies for piercing thick stock, the die was made 6 per cent of the thickness of the stock larger than the punch, and with a clearance angle of $\frac{5}{8}$ inch per foot. The blank was located by gages held on the face of the die, and was stripped from the punch by a $\frac{3}{4}$-inch machine-steel stripper, both of which are not shown in the illustration. The punch, which is not shown, was of ordinary construction but great care was exercised when sharpening it, to give it a shearing cut in order to decrease the strain when cutting such thick stock.

When in use, it was found that the $\frac{1}{8}$-inch strips *C* (Fig. 2), which were set into the die, began to settle in the die-holder, so to overcome this trouble the die-holder was planed out $\frac{1}{2}$ inch deep by 1 inch wide, and hardened steel strips were inserted close to the clearance holes. This gave a firm support to the die members, and no further trouble was encountered on this point.

The first attempt to bend this blank was made with a punch and die somewhat similar to that shown in Fig. 3, but after bending a few samples and checking the dimensions, it was found that the $\frac{1}{8}$-inch webs were out of line, and that the spacing of the holes lengthwise was uneven. As the holes were required to be in line, and in the correct relation to each other, these irregularities were not allowable. This first die was just a plain die without any guiding members to fit in the pierced holes and thus prevent the partitions from bending.

The next plan adopted was to bend the blanks in a die which had projecting blocks fastened in it, that fitted in the holes in the blank. Corresponding holes were also cut in the punch for these projections made in the die. This method was also a failure, as it was found that the blanks would stick in the die, and it was necessary to pry them out, which changed their shape.

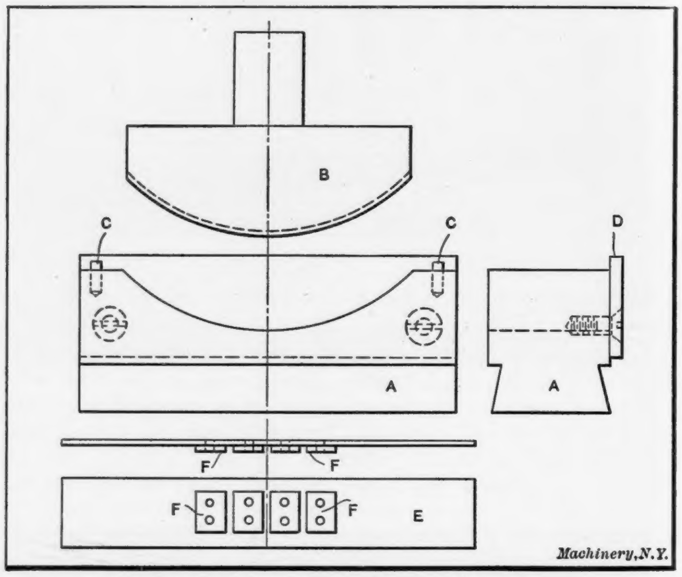


Fig. 3. The Successful Bending Punch and Die

The final bending punch and die used for this operation, and which gave satisfactory results, is shown in Fig. 3. The die *A* and punch *B* were made plain, as shown, the die having two locating-pins *C* for locating the blank lengthwise, and a strip *D* for locating it sidewise. A flexible steel spring *E* was made, and four blocks *F* riveted to it, as shown. These blocks were made the size of the holes in the blank, and were located on the flexible spring to correspond with the holes. The punch *C* was cut away as shown by the dotted lines, to fit the steel spring *E*, so in this way the spring was located by the pins *C*, the gage *D* and the projecting edges of the punch.

In operation, the blank is located on the face of the die, and the flexible steel spring *E* placed on top of it, with the blocks *F* located in the holes. Then as the ram of the press descends, the punch *B* forces the blank and flexible spring into the die, giving the blank the desired shape. When the punch ascends, the blank and spring still remain in the die, but by giving the die a slight tap, the spring is released and flies back to its original shape, when the blank can be easily removed from the die.

* * *

The interior of gear boxes is likely to retain some sand even if ordinarily well cleaned. To avoid trouble from sand working loose and getting into the bearings, the inside should be painted or shellaced. One or two coats will securely hold stray grains of sand and perhaps save cutting out a bearing.

* Address: 254 Mason St., Milwaukee, Wis.

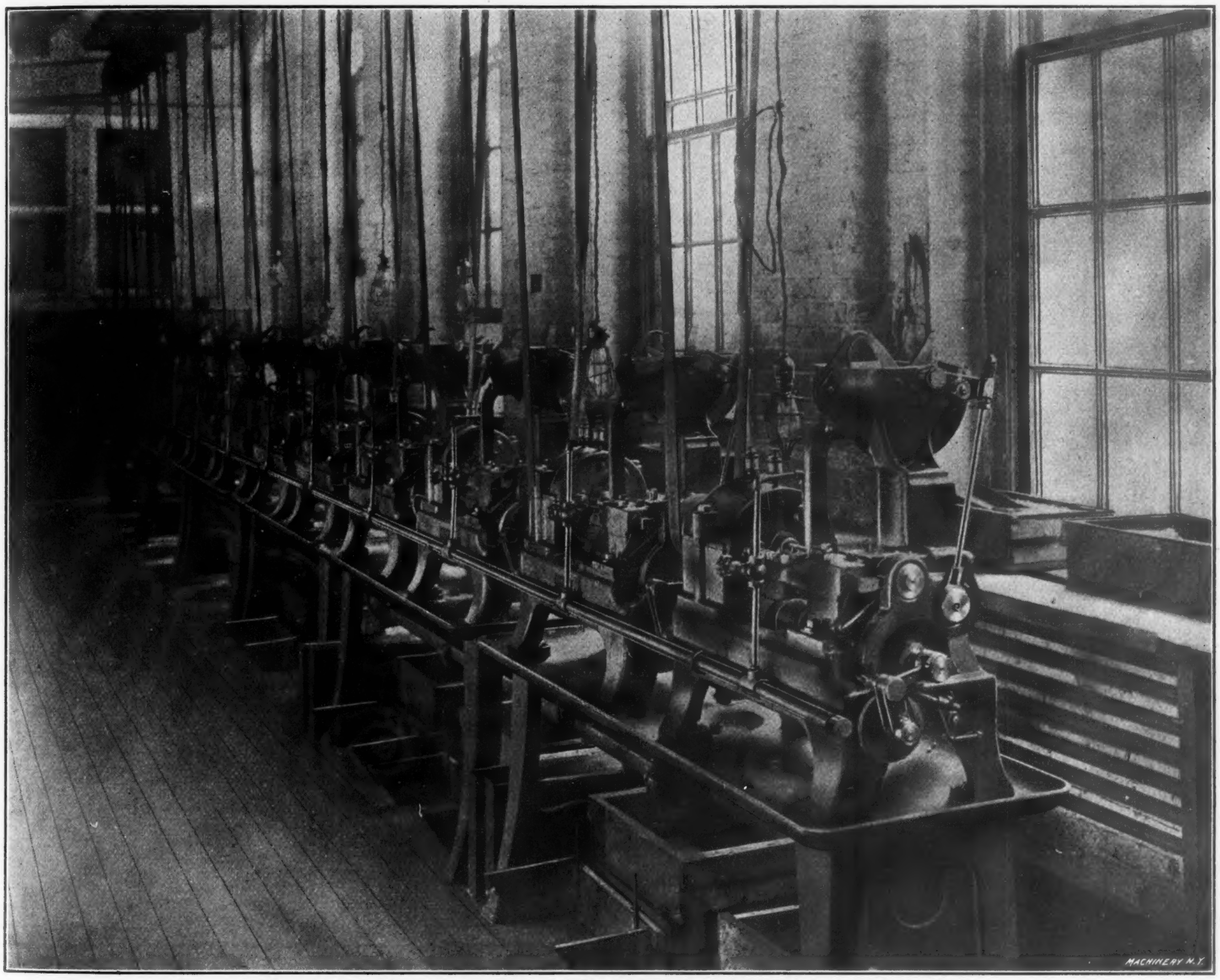
RAPID NUT TAPPING

The illustration shows a battery of twelve automatic nut tappers installed in the plant of the National Screw & Tack Co., Cleveland, Ohio, by the Acme Machinery Co. of the same city. These machines are remarkable for the speed of output and consequent low cost of tapping. One operator attends four machines and each machine taps from 34,000 to 36,000 ¼-inch nuts per day of ten hours. The labor cost per thousand nuts is less than 1½ cent.

Each machine has three spindles and three taps, but only one spindle and tap is in operation at once. The nuts are automatically fed to the revolving tap from the bottom of a hopper and when the tap shank is full, the turret automatically revolves, bringing the next spindle and tap into action. The operator loosens a set-screw holding the shank and unloads the tapped nuts, then replacing the tap in its spindle. There is no backing of taps out of the nuts, and consequent loss of time and stripping of threads. The operator's work is simply keeping the hoppers filled and discharging tapped nuts from the taps.

The National Screw & Tack Co. has fifty of these machines in use, thirty of which are the No. 1 size (3/16 to 5/16 inch capacity); eighteen of the No. 2 size (⅜ to ½ inch capacity); and two of the No. 3 size (⅝ to 1 inch capacity). Six more of the No. 1 size are now being installed, which will make a total of fifty-six.

A soap compound is used for cooling and lubricating the taps. This is pumped to the machines from a common supply through pipes and returns by gravity to the supply tank.



Battery of Acme Non-reversing Automatic Nut Tappers in Plant of National Screw & Tack Co.

* * *

The following formula for making phosphor-bronze castings of a tensile strength as high as possible is recommended by *The Foundry:* Copper 90 per cent, tin 4 per cent, five-per-cent phosphor-tin 6 per cent.

NON-FERROUS CASTINGS FOR HIGH PRESSURES*

The results of investigations covering over three years, which had in view the determination of the best non-ferrous alloys capable of withstanding high pressures, are contained in the following article:

The alloys commonly used come under two general heads: Gun metals consisting principally of copper, tin and a little zinc; or complex brasses containing mostly copper and zinc. Manganese bronze as applied to this latter class is misleading, it being really a brass composition with minor ingredients which in no case exceed two per cent. Gun metals have only a moderate strength and ductility, while this manganese bronze constitutes a considerable advance in both respects.

An example will illustrate the casting difficulties to be contended with: When the copper and tin are melted, dross or scum is formed by oxidation, and gas is dissolved in the melted alloy. At the proper temperature the zinc is added and the dross removed by stirring and skimming, and the metal is then poured through a gate designed to trap any dross into a sand mold, the temperature being enough above the freezing point to allow the metal to flow readily. This causes shrinkage which continues to the freezing point, below which contraction occurs. The solubility of the dissolved gas diminishes as the temperature drops, causing an evolution of gas at the moment of incipient solidification. The liquid being quite viscous, entraps these bubbles thereby causing sponginess in the castings. Blow-holes in the metal may be occasioned by the mold. Another source of unsoundness is caused by the segregation of tin-rich mixtures caused by the unequal rates of cooling. Faulty patterns are another cause

* Abstract of a paper on "The Production of Castings to Withstand High Pressures" presented before the December meeting of the Institution of Mechanical Engineers by Prof. H. C. H. Carpenter and C. A. Edwards.

of failure principally due to the changes in size not being gradual.

The plan of investigation outlined was as follows: To work out the conditions for success for the simplest cases and having this achieved, to introduce one complication at a time with the object of finally considering an ordinary industrial case. The castings contemplated were to have mechanical strength, homogeneity, soundness, freedom from deterioration and minimum corrodibility.

The first step was casting a cylinder in a chilled mold, in this way eliminating mold and pattern difficulties and also reducing to a minimum blow-holes and sponginess, the rapid cooling being one of the chief aids to the escape of gas. At the outset experiments were made with pure gun metal containing only copper and tin in the ratio of 85 to 15. Cylinders with ¾-inch bore and wall thickness also of ¾ inch could withstand 18 tons hydraulic pressure before bursting, no signs of leakage being apparent up to this point.

These same cylinders were next cast in both green and dry sand molds but the results were unsatisfactory, even though attempts were made to quickly cool the castings by imbedding blocks of metal in the sand. The failure was attributed to the segregation of tin-rich areas. These experiments were not continued further as it was learned that metals of this composition deteriorate with time.

Aluminum bronzes were next considered. From previous experiments these appeared to have the following advantages: Even though cast in sand there is no segregation owing to the small freezing interval; they possess considerable tenacity and homogeneity, the former falling, the latter rising as the aluminum is increased; and alloys of this composition are readily made and have but slight corrodibility. The first of these were cast in the chilled molds at 80 degrees above freezing point. While signs of dross were apparent, it was confined to the surface and did not affect the soundness of the material, as 18 tons pressure could be withstood without failure. Green sand castings of the same composition were not satisfactory as one-half of them failed in the preliminary low pressure test, while the others remained unbroken even after the wall thickness had been reduced purposely to ¼ inch. Experiments with a stiffer material were decided upon and cylinders were made containing from 9.5 to 11.5 per cent aluminum. Up to 11 per cent the qualities of the metal were improved, but beyond that point the bronze became brittle and remarkably inferior.

The next step was to produce castings in more complicated forms, a hydraulic valve block consisting of lug, barrel and base-plate, being chosen as an example. This proved unsuccessful, so with an idea of simplifying the problem, the base-plate was removed and only the barrel and lug cast.

Experiments were made to clear the fluid metal by the addition of deoxidizing agents, but unsatisfactory results were obtained. The fluxes used were magnesium, calcium silicide, sodium carbonate, manganese and a mixture of sodium carbonate and borax. Inferences drawn from these tests were that while these metals are very viscous in a liquid state, this is not due to the metal itself but to a tenacious film of alumina which invariably covers the surface. As the liquid metal would offer little resistance to the natural rise of the dross to the surface, it was concluded that the dross was in some way formed inside the mold. This is caused by the constant oxidation of freshly exposed surfaces when the metal enters the mold in ripples or waves, causing the formation of a large amount of dross which sticks to the mold. From this it follows that aluminum bronzes should be poured very quietly and any agitation of the metal avoided. Also the metal should enter the mold at the lowest possible point through a rather narrow opening, and in the case of green sand molds wet sand must be avoided particularly in the lower parts where the metal rests on the sand.

Microscopical examination showed that the structural constituents of aluminum bronze were the same no matter whether the casting is large or small within the limits of these experiments.

Test pieces of the same general size as the valve blocks when tested for strength gave an ultimate strength of 55,000 pounds per square inch, while similar tests made on pieces cast at a lower temperature failed much lower.

Tests with these bronze castings for high-pressure steam especially when superheated, are being conducted by experimenters but the results are not contained in this record.

* * *

TABLE FOR CALCULATING THE OUTSIDE DIAMETER OF WORM-WHEELS

By J. A. FUCHS*

The regular formula for calculating the outside diameter (to sharp corners) of a worm-wheel, as indicated in the accompanying illustration, is:

$$D = 2\left(A - A\cos\frac{a}{2}\right) + d$$

in which

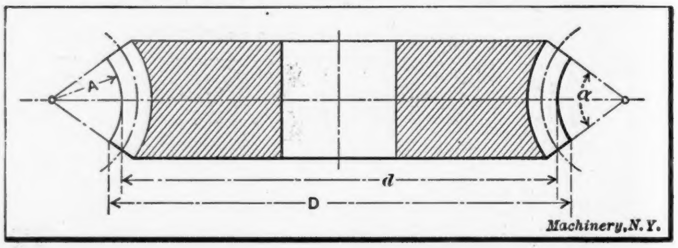
D = the outside diameter of worm-wheel to sharp corners,
A = the radius of the curvature of worm-wheel throat,
a = face angle of worm-wheel,
d = throat diameter of worm-wheel.

By writing this formula in the form:

$$D = 2A\left(1 - \cos\frac{a}{2}\right) + d$$

it will be seen that the expression within the parentheses can be tabulated for various face angles, and such a table is given herewith. By using this table and calling the values found in the table for various angles, C, the formula takes the simple form:

TABLE OF FACTORS C USED IN WORM-GEAR FORMULA



Angle a, Degrees	Factor C	Angle a, Degrees	Factor C	Angle a, Degrees	Factor C	Angle a, Degrees	Factor C
30	0.034	46	0.080	62	0.143	78	0.223
31	0.036	47	0.083	63	0.147	79	0.228
32	0.039	48	0.086	64	0.152	80	0.234
33	0.041	49	0.090	65	0.157	81	0.240
34	0.044	50	0.094	66	0.161	82	0.245
35	0.046	51	0.097	67	0.166	83	0.251
36	0.049	52	0.101	68	0.171	84	0.257
37	0.052	53	0.105	69	0.176	85	0.263
38	0.054	54	0.109	70	0.181	86	0.269
39	0.057	55	0.113	71	0.186	87	0.275
40	0.060	56	0.117	72	0.191	88	0.281
41	0.063	57	0.121	73	0.196	89	0.287
42	0.066	58	0.125	74	0.201	90	0.293
43	0.070	59	0.130	75	0.207	..	.....
44	0.073	60	0.134	76	0.212	..	.....
45	0.076	61	0.138	77	0.217	..	.....

$$D = 2A \times C + d$$

in which C can be found in the table for any angle from 30 to 90 degrees.

* * *

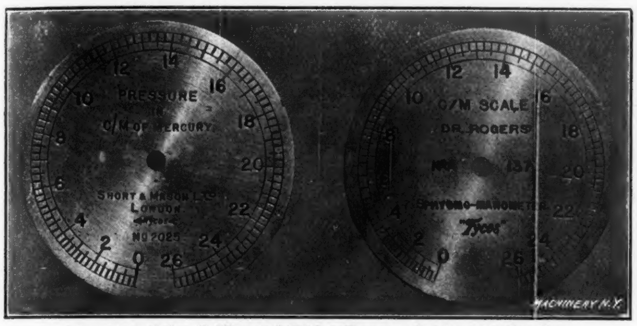
In a recent number of *The Mechanical Engineer*, the value of the pyrometer as an adjunct in steel hardening, is discussed. While an expert mechanic can usually distinguish small temperature differences from the appearance of the tool being heated, the actual temperature is usually more or less in doubt, and the results obtained on successive occasions are seldom exactly the same. By a pyrometer, the temperature can be adjusted exactly to suit previously determined best conditions. While pyrometers made of the rare earth elements are more sensitive, they are fragile; and a newer type constructed of the baser elements answers equally well for this work.

* Address: 39 Sayre St., Elizabeth, N. J.

ENGRAVING CALIBRATED CIRCULAR SCALES

The graduated circular scales shown in Figs. 1 and 2 are used on the sphygmo-manometer, an instrument employed by the medical profession to determine the blood pressure in the arteries. Each instrument is calibrated and its scale is engraved to suit. Comparison of the two scales illustrated shows considerable difference in the length of the graduated arc.

The graduation lines are radial, and the problem of cutting them to suit each calibration presents no special difficulties, but engraving the figures 0 to 26 inclusive is made difficult for



Figs. 1 and 2. Calibrated Disks Engraved after Graduation

the reason that the position of each number is changeable and its base must be kept parallel to the horizontal diameter. The Geo. Gorton Machine Co., Racine, Wis., lately fitted out a maker of surgical instruments with a Gorton engraving machine and a special fixture for the copy-holder for engraving these numbers, which has some interesting features.

The fixture shown in Fig. 3, provides copy for the graduation numbers, the name of the instrument, etc., and the serial number. The copy for the serial numbers is made of T-shape

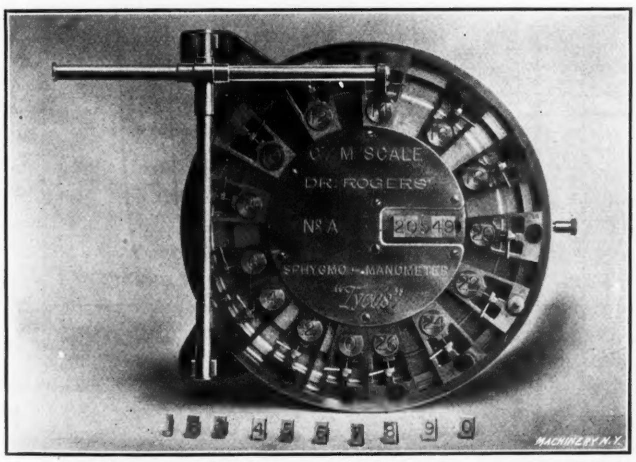


Fig. 3. Jig Copyholder for Adjusting and Holding Copy to suit each Disk

vertical section, as is shown in the illustration of "1" and "2" at the bottom. The copy for the figures is clamped in the slot by the thumb-screw at the right. The serial number part of the jig is simple, and no more explanation is necessary. The copy for the graduation numbers is on circular studs. Each stud can be twisted on its axis and each stud with its holder can be adjusted on the circle to suit the graduation of the

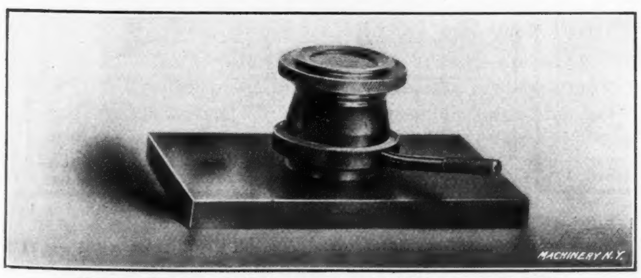


Fig. 4. Chuck for Holding Graduated Disk for Engraving

scale to be engraved. The method of using the jig is as follows:

The graduated disk to be engraved is held in the chuck, Fig. 4, and mounted on the work table of the engraving machine. The chuck, shown disassembled in Fig. 5, admits of adjusting the disk holder relative to the base of the chuck and the machine after the disk has been clamped. This feature is a necessary provision in order to set the disk so that the name, serial number, etc., shall be engraved on lines at right angles to the vertical axis of the circle drawn midway between the end graduations.

The operator clamps the engraved disk in the chuck and then twists the chuck around in the base until a line drawn through the extremities of the end graduations would be parallel with the horizontal axis of the copy holder, Fig. 3. The stud carrying No. 0 is loosened and the stylus point on the pantograph arm overhanging the copy is dropped in a prick mark in the stud-holder sector that can be seen between the stud and its clamp screw. Meanwhile, the set-screw holding the sector to the base has been loosened and the cutter in the work spindle is dropped into the first graduation. The sector is thus shifted to the correct place and is clamped by the set-screw to the base. The stud then must be squared, and this is accomplished by the sliding bar square, pivoted at the left, which provides for lateral and vertical adjustment of the small squaring blade shown over stud No. 14. Each stud has a cut across its upper face, thus making a face to square by. The stud is first lo-

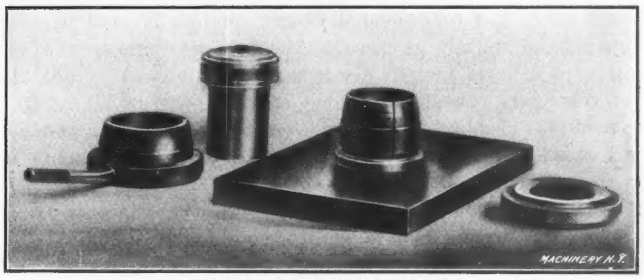


Fig. 5. Chuck Disassembled

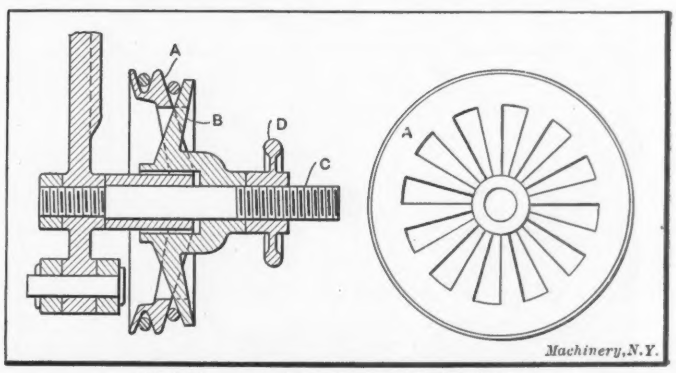
cated to correspond with the graduation on the disk to be engraved and then is squared and clamped in place.

After setting the studs, the engraving of the calibration numbers, serial number, name of instrument maker, etc., is done the same as any other engraving to which the Gorton machine is adapted. The copy just described is several times larger than the engraved disk, the latter being 1 7/16 inch diameter; the reduction of scale is accomplished by setting the pantograph reducing motion to the desired scale. F. E. R.

* * *

VARIABLE-SPEED MECHANISM

A construction embodying an old principle is dealt with in U. S. patent No. 975,869 (November 15, 1910) issued to John G. Jones, Rochester, N. Y. It provides for the transmission of small power from a driving shaft to a driven one in such manner as to permit the speed of the latter being varied easily, quickly and noiselessly when circumstances require.



Variable-speed Power-transmitting Mechanism

From the engraving it will be seen that it consists essentially of two cones *A* and *B* on a shaft *C*. The cone *A*, a face view of which is shown in the view to the right of the section, is secured rigidly to the shaft *C*, and is the driving member, its periphery being formed for a belt of any desired shape. Cone *B* is free to slide on the shaft, its movements being regulated by adjusting device *D*.

The two cones are so formed with radial slots that the one may fit into the other. This provides a circular V-shaped groove whose diameter can be adjusted at will, giving a wide range of speed ratios.

RAILWAY TERMINALS

The great railroads complain of the lack of terminal facilities, and most of the delays of freight transportation are laid to this limitation. Ways and means are being generally discussed for increasing yards and facilitating the movement of freight, but practically all the plans involve the expenditure of millions of dollars, and millions of dollars are not easy to get in these days of general distrust of railroad management. As the business of transportation increases, terminal congestion will become more and more acute if present methods are followed. In fact, it can be demonstrated that terminal yards of area in proportion to the tonnage that in all probability will be carried to the great lake and sea ports in 1950 will be a physical impossibility at points within a radius of ten miles of the centers of population. The theory that great freight terminals are necessary for great centers of population must be abandoned the same as it has been abandoned for heavy passenger traffic in a few cases. The Brooklyn Bridge and the loop of the Hudson & Manhattan R. R. are terminals for passengers but not for cars. Why should freight cars be held for days to discharge freight? It is easily possible to unload a 40-ton gondola of coal in four minutes, and equally as remarkable improvements in the unloading of general freight are perhaps possible. Let the railroad managers concentrate some of their energy on solving the terminal problem as it must eventually be solved, and not try instead to burden the country with vast investments in the present types of terminals that are so wasteful of time that the average daily movement of freight cars is only twenty-four miles, as has been shown by reliable statistics.

* * *

The problem of automatic stability of aeroplanes seems to have been solved, or at least to be nearing its solution. Lieut. J. W. Dunne, an Englishman, recently gave an exhibition with his automatic stability biplane in England. He made two flights of seven and eight miles each, and was able, as he flew, to take his hands off the control levers and to write notes while the machine continued on its course. The Dunne machine is a fairly heavy one and is shaped much like a snow plough with the sides open. It has neither tail nor rudder and depends for its steering power on two small flaps at the rear edge of the upper plane.

PRESS TOOLS FOR MAKING SMALL HINGES

By DESIGNER

Among the parts of the Fay-Sholes typewriter is a small hinge known as the short pressure plate hinge, shown in its finished form at *A* in Fig. 1. The tools for the manufacture of this hinge are shown and described in this article. In Fig. 2 is shown the blanking tool. The die *A* is made up of two pieces of hardened and ground tool steel, fitted together as shown, and fastened to the machine-steel die-block *B* by screws *C*, and located by dowels *D*. The stripper *E*, of machine steel, is fastened to the die-block by means of screws *F* which are

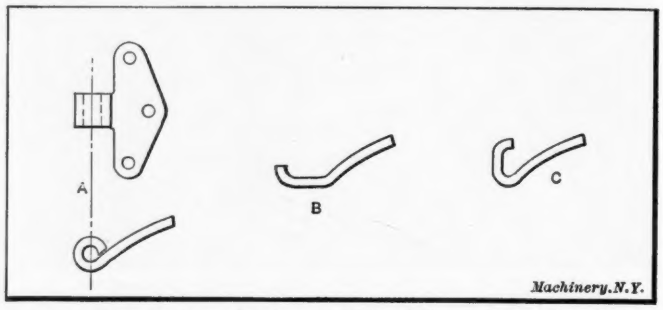


Fig. 1. Hinge to be made, shown in Natural Size, and Two Stages of Completion

tapped into it and also fasten the die-block to the base casting, the heads of the screws being countersunk in the latter. The dowels *G* locate the stripper on the die-block. A finger stop *H* is provided for locating the stock. This stop is actuated by a pin in the plunger casting.

The punch *I* is fitted tightly into the machine-steel punch-block *J*, and is backed up by a pack-hardened bearing plate *K*, to which it is fastened by a flat-headed screw *L*. The hardened plate is also screwed to the punch-block, and the latter is screwed to the plunger casting, the screws being tapped into the punch-block, and the heads countersunk in the plunger casting.

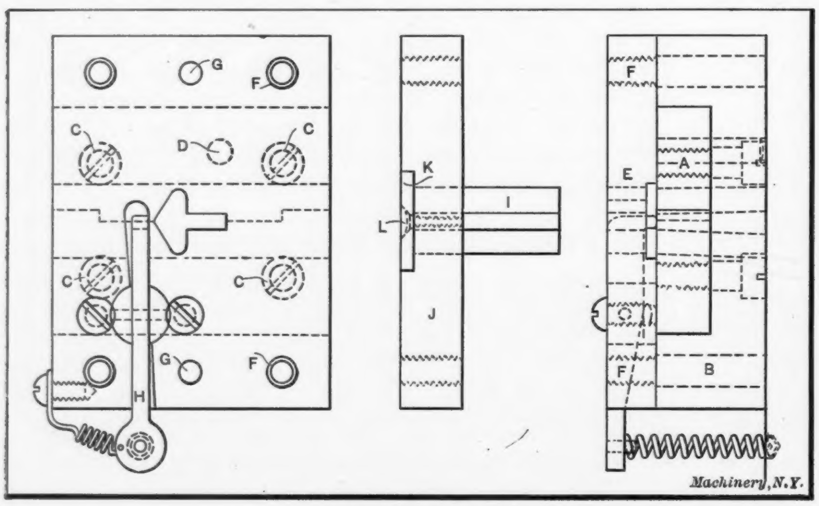


Fig. 2. Blanking Die for Hinge

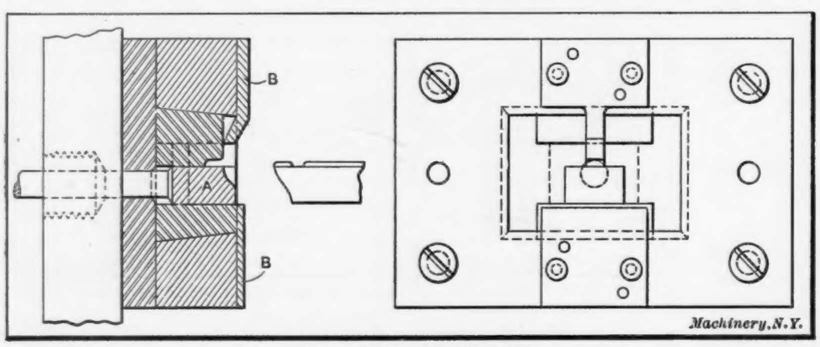


Fig. 4. Second Bending Die

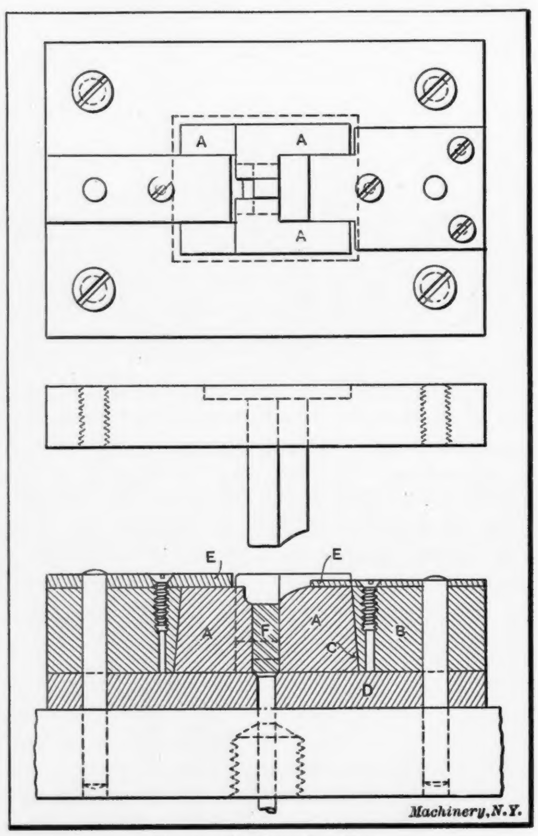


Fig. 3. First Bending Die

Fig. 3 shows the first forming tool. Fig. 1, at *B*, shows the shape of the piece after leaving this die, in which one end of the piece is bent up, and the curl started at the narrow end. The construction of this die is somewhat different from the former. The die in this case is made up of three pieces, *A*, fitting together and wedged into the die-block *B* by making

the sides with a taper of 5 degrees as shown at *C*. A hole is worked out in the die-block to receive the die, thus making the use of screws and dowels unnecessary. A machine steel pack-hardened backing plate *D* is provided under the die-block as a backing surface for the die. The punch is made as described for the first tool. Gage plates *E* of machine steel, pack-hardened, are provided for locating the work; the latter, when in position, rests on the pad *F*, which is shown depressed in the drawing, and which is returned to its normal position by a spring-pressure device not shown in the illustration.

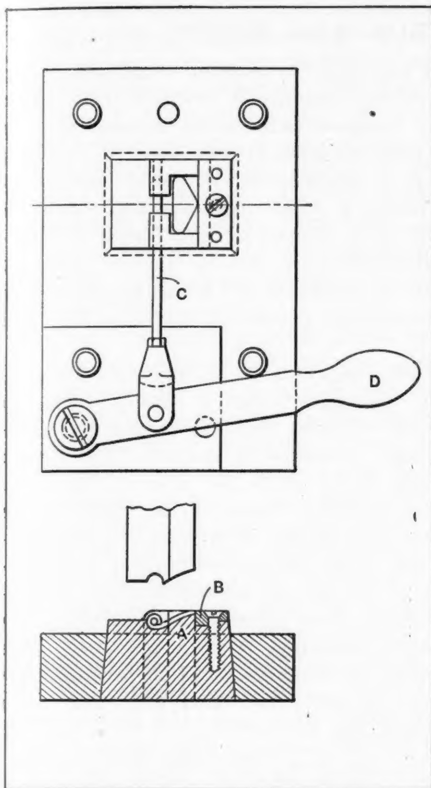


Fig. 5. Final Curling Die

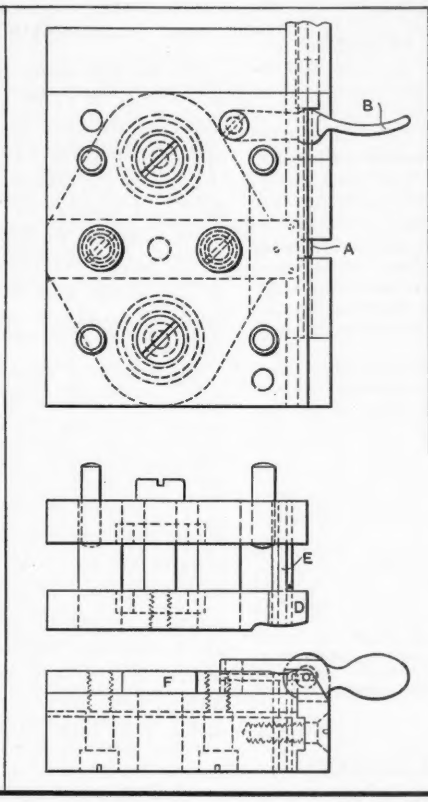
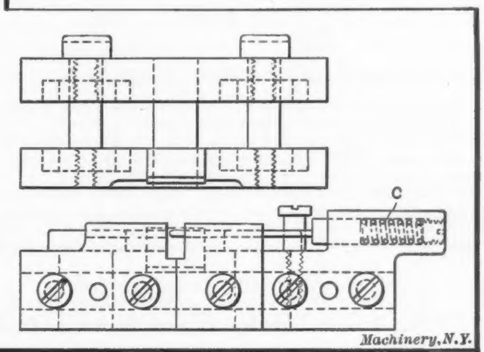



Fig. 6. Piercing Die for Holes

The punch and die in Fig. 4, which, in general construction, is similar to that shown in Fig. 3, performs the next step of further forming the curl at the narrow end. The piece after the operation is shown at *C*, Fig. 1. The work, located by gage plates *B*, rests on the pad *A*, and is carried down into the die on the pad on the down-stroke of the press until the bend is completed to the form shown in Fig. 1. It is then lifted out by the punch and falls back onto the die.

Fig. 5 shows the tool for closing in the eye partly formed by the previous operations. The piece after this operation appears as shown at *A*, Fig. 1, except that the holes have not yet been pierced. In Fig. 5, the piece is laid on the die *A*, and rests against the gage plate *B*. The arbor *C* is then pushed into position, being actuated by the lever *D*. The punch curls the projecting end around the arbor, completing the curl. The arbor is withdrawn from the finished piece by a reverse movement of the lever, and the piece is readily removed from the die.

Fig. 6 shows the punch and die for the last operation, that of piercing the three holes. The piece is located as shown, and is held by the arbor *A* which fits into the eye. The arbor is moved out of the way for the insertion of the work, by the handle *B*. When the piece is in position, the arbor is moved into place by the spring *C*. The stripper *D* holds the work firmly while the piercing punches *E* operate. The pieces *F* are bearing surfaces for the stripper to strike against.

* * *

HOW TO MAKE MONEY AT HOME!

A country boy desiring funds to complete his education took a correspondence course in mechanics and began to manufacture locomotives at home, sending out the completed work in neat cartons. He now supplies his engines to most of the big railroads. His example is worth following by those fond of light home work.—*Wex Jones.*

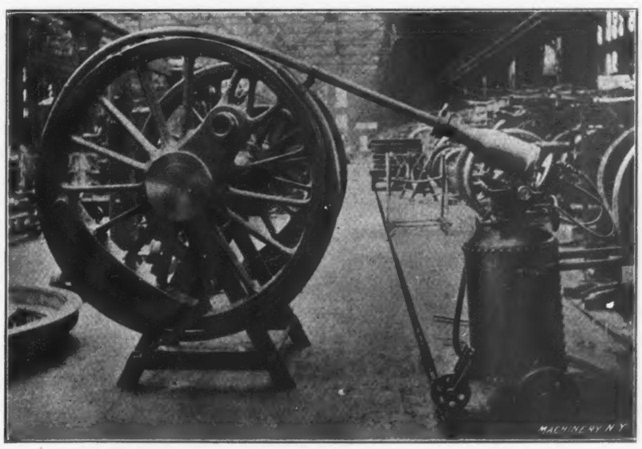
FUEL OIL LOCOMOTIVE TIRE HEATER

By FRANK C. PERKINS*

The fuel oil tire heater shown in the accompanying illustration is self-contained in its construction and simple in its operation. It is interesting to contrast the ordinary tire heater which uses three to four gallons of gasoline and takes from 20 to 30 minutes to remove a tire with this fuel oil tire heater, which is said to require only from 1½ to 2½ gallons of fuel oil, taking only 6 to 10 minutes to do the work. The saving in fuel and time is at once apparent.

The portability of the equipment is a valuable feature, as the heater is mounted on wheels and may be conveniently moved about in the shops to the different wheels from which the tires are to be removed. In utilizing the apparatus, the heater is pushed to the locomotive and the pipe adjusted to the tire. Upon turning on the oil and air, the combustible mixture is sprayed into the retort chamber or gas producer, and ignited. At first only a small quantity of oil is allowed to pass into the chamber, and upon ignition, the carborundum lining of the chamber is rapidly heated to a white heat, when more oil is then allowed to spray into the chamber; and this, coming in contact with the heated lining, is at once vaporized, the highly heated vapor or gas passing into the burner and issuing from the openings at which it is ignited.

It is stated that the vapor or gas burns with an intense heat at the openings; and, as these openings are placed close together and almost entirely encircle the tire the latter is quickly heated so that the time required for its removal is reduced to a minimum. The cost of the operation is thus materially reduced, and there is also a considerable saving in fuel as well as in the time required for the operation. It is maintained that this fuel oil tire heater produces no smoke, which renders it especially useful for indoor use; at the same time it is simple in construction, safe and easy to operate and very economical.



Apparatus for Removing Locomotive Tires, using Fuel Oil

*Address: Erie Co. Bank Bldg., Buffalo, N. Y.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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APRIL, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

VENTILATION OF DRAFTING-ROOMS

Good ventilation is a topic that is being discussed continually by those who would improve the general conditions in homes, factories, and public buildings. The subject is not of great importance in the general run of machine shops, as the construction, size of the buildings and mode of heating modern plants, generally provide plenty of fresh air; but in many drafting-rooms the conditions are quite different. Draftsmen require warm rooms in winter in order to work comfortably, and the tendency is to exclude fresh air when weather conditions are severe. The result is vitiated air, and the consequent lassitude that is a foe of the active mind and hand. Provision should be made for a plentiful supply of fresh air, warmed to a temperature of about 68 to 70 degrees F. and of the proper degree of moisture. The more moist the air, up to a certain degree, the lower will be the comfortable temperature. The air in a room heated by steam pipes tends to become very dry, and a higher temperature is required for comfort than when the air has absorbed the proper amount of moisture, which is about 70 per cent on the humidostat scale. The provision of moist air permits freer ventilation in cold weather without discomfort than is possible with very dry air.

* * *

CLEAN VS. DIRTY SHOPS

A man's surroundings react upon his ideals, mode of thought, and ways of working. The workman who comes from a slovenly home where meals are badly cooked, the house in a litter and things generally in a disordered state, will, in the natural order of things, be a slack and unsatisfactory workman. His moral stamina will be low and his ambition listless. The best workmen generally, are those having cheerful homes, good wives and happy children. They have something to live for and work for—ambition to some day, perhaps, hold a position of responsibility.

Granted that this is true, why should a manufacturer require his workmen to work in a dirty, ill-kept shop—where old waste and oil slip under a man's feet as he walks, and where the machines are coated with grease that never has been cleaned off since they were bought?

Cleanliness costs, and so does almost everything that is worth while; but it pays in the long run. It pays in the effect on the men, in tending to raise the standard of workmanship, in elevating moral standards, in reducing fire risk, and in saving machinery from abuse. By all means cleanliness pays, and the dirty shop is always a reproach to the management.

* * *

SPEEDS AND FEEDS

For several years it has been the fashion to provide a very wide range of speed and feed changes on machine tools. Gear boxes galore have been designed to facilitate changes, and the cost of machines has been considerably increased by features that some purchasers now regard as being of little use. Well-informed mechanics, foremen, superintendents and managers know that the working limits of most machines used in manufacturing are comparatively narrow. Probably ninety per cent of the lathes and drilling machines would be as efficient as they are to-day if one-half the speed and feed changes were eliminated.

Machine tool users are beginning to realize that when an engine lathe is bought having a range of speeds and feeds much wider than is ever required they are paying for something practically useless. Changes in machine tool design are being made to meet the demands for greater simplicity. In the words of one well-known maker it is, "back to the simple life" in machine tool design as well as in other avenues of activity. No one questions the desirability of providing convenient means of getting all needed changes on toolroom machines or machines used in jobbing shops, but these are a comparatively small percentage of the total output. The policy should be to build the machine to fit the average conditions and price it accordingly. Let those who want more order what they want and pay for it.

* * *

ECONOMY OF EFFICIENT FIRE PROTECTION

The annual fire waste in the United States is appalling, exceeding $100,000,000 by conservative estimate. This estimate is for the actual loss of property, there being no data, of course, for the loss of wages and profits, and indirect business losses generally. The fire insurance companies, as a matter of good business policy, have brought about many reforms in factory construction designed to greatly reduce the fire risk. The growing use of concrete is another factor that should tend to reduce the proportional loss, though it is doubtful if the aggregate fire waste will show perceptible diminution in the next twenty years, or until a large part of the present wooden structures have burned or been torn down.

Among the means for preventing destructive fires, the sprinkler system, which originated in the needs of woodworking mills, is the chief. There is little chance for a fire started in a building equipped with sprinklers as prescribed by standard specification, to become a destructive conflagration. The moment the temperature of the air surrounding the sprinkler head reaches or exceeds 180 degrees F., the fusible links melt and the flow of water automatically starts. If the fire spreads, more sprinklers go into action and unless the conditions are abnormal the flames are promptly extinguished.

The experience of a well-known machine tool builder of the Northwest is a good illustration of what this system means in saving insurance premiums. For several years the plant consisted of wooden buildings, and being outside the city fire protection zone, the insurance rate was high, the premium being about $3000 annually. A new building of semi-fireproof construction has been built and equipped with the sprinkler system throughout. The annual premium on twenty per cent more insurance is only about $200. Counting ten per cent interest and depreciation on the investment in the protective system, there still remains a large annual saving, and besides that the greatly added security of the business, which has required years of hard work to build up.

MAKESHIFT DEVICES

In many lines of manufacturing, special machines and appliances are required for economical production, jigs and fixtures and special tools being included in this generalization. These are generally made in the shops themselves, as the peculiar conditions and special features to be covered require specialists for the work, which is in the province of the toolmaking department.

How much further a purely manufacturing enterprise may go in turning out such work is open to question. Machines of a highly specialized nature are often built at home at heavy cost in order to keep the designs secret, and this class of work we are not considering. What we have in mind is the conversion of engine lathes into turret lathes, the adaptation of drill presses to odd and unusual uses, etc. In most adaptations of this kind the superintendent or manager is self-deceived in fancying that substantial savings have been made, and, although the converted tool may appear on the books at half, or less, of the cost of the manufactured tool, the chances are that it is of inferior design and capacity, and therefore an uneconomical machine.

However, the chief objection to the conversion of standard machines into special tools is that such work requires the time and thought of responsible men whose energies might more profitably be devoted to manufacturing economies. If a shop manager is designing special machines, he is using mental energy that, nine times out of ten, could be more profitably expended on his designs and in working out ways and means for increasing and improving the output. The general tendency of progressive manufacturers is to use standard machine tools on those lines of manufacture which are produced in comparatively small lots. Of course, where the production runs into thousands yearly, the saving effected by combination machines that drill, bore, ream, face and tap a casting at one setting is enormous. But if the equipment is to comprise such machines, they should be designed and built by men not directly responsible for the manufactured output.

* * *

OPPORTUNITIES IN THE MACHINE TOOL BUSINESS

In these days when "big business" and monopolies seem to be the rule, it is encouraging to the ambitious mechanic to be assured of the opportunity for individual success of the brainy man who elects to build machine tools. The man with experience and good ideas can build machines that will sell in competition with the largest concerns, with profit. He must perhaps act in the early years of his venture as designer, draftsman, superintendent and salesman, but the fact that he can combine these functions under one hat gives him some advantage over the top-heavy expensive organization in which the president and other responsible officials are so far removed from the atmosphere of the shops and its needs and are so harassed by the details of the administrative side of the business that their personality is not impressed on the product. Moreover the cost of administration puts the big business out of competition where the product is of a specialized character. Inventive skill combined with good judgment and business ability has many a good chance for success in machinery building, and the more of the small fry that become successful building special tools, the better it seems to be for the big concerns building standard lines.

* * *

INDUSTRIAL SAFETY ASSOCIATION

At a dinner given by Mr. David Williams at the Engineers' Club, New York, March 1, the plan and scope of the newly organized Industrial Safety Association were outlined by Mr. Williams and the president of the association, Dr. F. R. Hutton. Copies of the first number of the *Journal of Industrial Safety*, the organ of the new association, were distributed among the guests; this means of public expression is one of the reasons for the birth of the organization.

The Industrial Safety Association is closely associated with the American Museum of Safety, whose quarters are in the Engineers' Societies Building, New York, and although of later origin it stands in the relation of a parent body to the Museum. The objects of the association, quoting from the constitution, are:

To prevent accidents to life, limb or body of persons engaged in productive industry, or in the occupations contributory thereto in which mechanical or other sources of power are employed; and to promote the health and well-being of persons engaged in the wage-earning processes and other occupations of life, by disseminating knowledge of sanitation and hygiene. These objects shall be sought by the association through the gathering together of knowledge on these subjects and by its distribution among the members and the public generally, by means of publications, lectures and other educational processes. The methods to be used by the association shall consist in collecting models, photographs, illustrations and examples of safety devices and apparatus designed to prevent or lessen accidents in industry and other occupations; in collecting literature and other information on the subjects of accidents and industrial hygiene and the maintenance of a library for free public reference on these topics; the conduct of research work and investigations into the effectiveness and improvement of safety apparatus; the maintenance and support of collections of such safety devices and their exhibition in museums in New York, and other cities as may from time to time seem desirable; and the conduct in every way of educational work along the lines of diminishing accidents and promoting better sanitation and hygiene.

The membership is divided into eight classes, *viz:* patrons, supporting members, contributing members, league members, members, associates, honorary members and corresponding members. The annual dues are: patrons, $500; supporting members, $250; contributing members, $100; league members, $25; members, $10; associates, $5.

Dr. Hutton in his remarks expressed the thought that the Industrial Safety Association would be better fitted to promote safety work than any of the great engineering bodies, such as the American Society of Mechanical Engineers, as it could work with all the great associations and secure cooperation and agreement on measures to be recommended to manufacturers, etc., for promoting the safety of industrial activities generally.

The importance of progressive and intelligent work that will promote safety in manufacturing and other activities should be better appreciated by the engineering profession. In the salutatory published in the journal, Dr. Hutton wrote:

An accident in a factory or shop is followed by a train of increased costs borne by some one or several. These costs include:

First, the proper compensation of the victim, who, for a longer or shorter period is unable to earn wages.

Second, the cost of litigation which follows the accident where employer and employed are not in perfect accord respecting the responsibility for it.

Third, the diminished rate of production, which follows the nervous shock to everyone who witnessed the accident and ran to the help of the sufferer.

Fourth, the time to train a new operative to the skill and speed of the disabled one, and losses from defective work during the process.

These appear inevitably in the cost of the production, and every buyer of the article manufactured pays his share in unnecessary prime cost.

The community, too, is concerned as its resources are wasted when an accident is unnecessary or avoidable, in paying for an ambulance, the hospital expenses and the care of the dependent. These resources should go to relieve unavoidable illness, failing strength from old age, and the surgical requirements of the best and most healthy community. Indirectly also the community is held back because children of the disabled men are taken from school before they are fitted for their life work.

The officers of the Industrial Safety Association see three general methods open to promote its work: The first is by maintaining a museum or exposition, such as is now the American Museum of Safety. The second is by lectures illustrated with photographs showing safety devices, causes of accidents, sanitary improvements, etc. The third method is by the circulation of printed matter of which the *Journal of Industrial Safety* is an example. This will reach those unreachable by exhibition or lectures and perhaps will be fully as effective as the other two combined.

Further information regarding the association can be obtained from the assistant secretary, Mr. M. S. Hutton, 29 W. 39th St., New York.

SHRINKAGE AND FORCED FITS*—1

By WILLIAM LEDYARD CATHCART†

A shrinkage fit is a cylindrical or slightly conical joint between two machine members, as a crank-web and a shaft, in which the bore of the outer member or crank is smaller than the diameter of the inner member or shaft, so that the outer member must be expanded by heat before it can be set in place, while, in the subsequent cooling, it contracts and grips the inner member with a force which depends on the character of the metals, on the thickness of the outer member, and on the difference between the original diameter of the bore and that of the inner member. This difference is called the *allowance for shrinkage*. A forced fit is based on the same principle and is virtually of the same character, except that the parts are forced together when cold by hydraulic or other pressure. It is the object of the following article to present a few fundamental formulas for the design of shrinkage fits and to show their application, as well as to place on record some data relating to this matter, obtained from practice.

Lateral Contraction

A stress, tensile or compressive, has not only full effect in its line of action, but also produces compression in a direction at right angles to that line. This action is called *lateral contraction*. Thus, referring to Fig. 1, if the short length between the planes *ab* and *cd* of a rectangular bar be subjected to the unit tensile stress T at right angles to the ends *ab* and *cd*, the stress in planes parallel to the line of action of T will be equal to T; but the stretching of the metal in the direction of this line causes a contraction in the directions which are perpendicular to it. This contraction is equivalent to that which would be caused by a unit compressive stress P_1, acting on the sides *bc* and *ad*, and by a similar stress P_2 acting on the sides *ac* and *bd*. The magnitude of these induced compressive stresses depends on the metal. For wrought iron

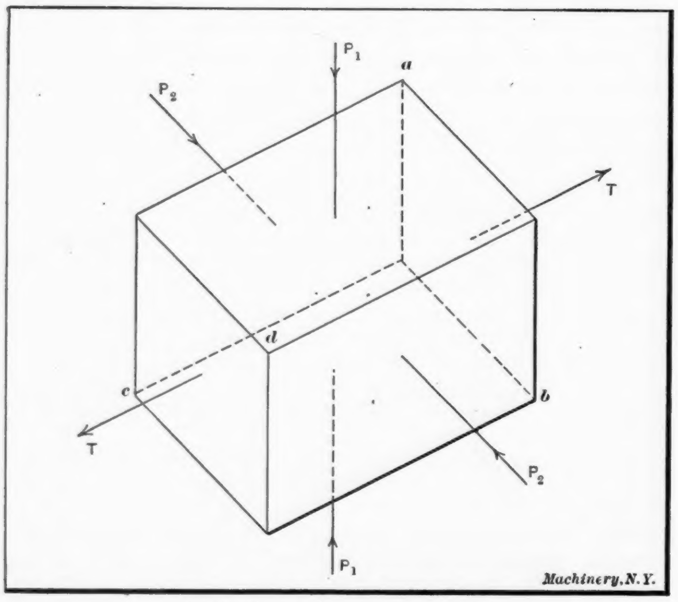


Fig. 1. True and Apparent Stresses

and steel, P_1 and P_2 are each taken usually as equal to 1/3 T; for cast iron, the ordinary values are about 1/4 T. This fraction, 1/3 or 1/4, is called the *factor of lateral contraction*, which factor will be designated by ϕ in the following.

If the unit-stress T, Fig. 1, had been compressive instead of tensile, there would still have been compression on planes parallel to its line of action, but that compression would then act outward from, instead of inward toward, the axis of the body. The lateral effect would be to elongate, not to contract. So far as is known, the factor of lateral contraction has the same value in compression as in tension. Thus, in Fig. 1, assume that P_1 and P_2 are direct compressive stresses and that there is no direct tensile stress like T. Then P_1 and P_2 will each develop lateral and equivalent tensile stresses, so that, since tensile stresses are taken as positive and compressive stresses as negative, the actual unit stresses will be:

In the direction of T, $\phi\ (P_1 + P_2)$.

In the direction of P_1, $\phi\ P_2 - P_1$.

In the direction of P_2, $\phi\ P_1 - P_2$.

A stress thus developed by lateral action is identical in effect, with a direct stress of its direction and magnitude. The

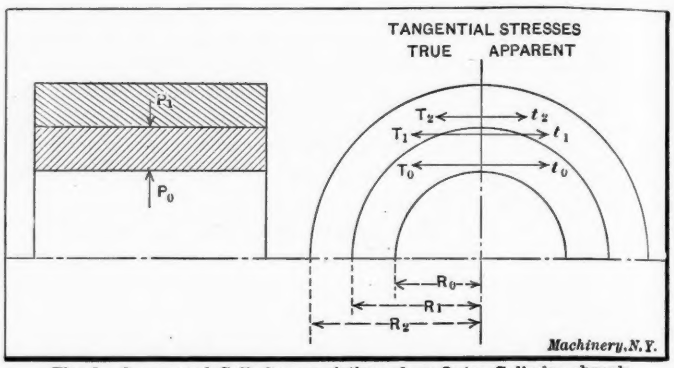


Fig. 2. Compound Cylinder consisting of an Outer Cylinder shrunk onto an Inner Cylinder

direct stress, which does not consider lateral contraction, if the latter exist, is known as the *apparent stress*, while the *true stress* is the algebraic sum of the apparent stress and the stresses in its direction due to lateral action. It should be borne in mind that the true stress is the actual stress to which the body is subjected and by which the deformation is caused.

Formulas for Compound Cylinders

The shrinkage fit is applied to a compound cylinder, *i. e.*, to two cylinders, one superposed on the other. The inner cylinder may be solid, as in the ordinary shaft, or hollow, as shafts and large crank-pins of steel are often made. Fig. 2 represents such a compound cylinder. There is no external pressure on the outer cylinder, except that of the atmosphere, which is negligible. In each member there exist a tangential or "hoop" stress and a radial stress. The latter is always compressive, and hence must be treated as negative when combined with other stresses. In the shrinkage fit, the metals of the inner and outer members may not be the same, and the tangential stresses at the contact surface also differ.

Let E = modulus of elasticity, outer cylinder,
E_1 = modulus of elasticity, inner cylinder,
ϕ = factor of lateral contraction, outer cylinder,
ϕ_1 = factor of lateral contraction, inner cylinder,
t_0 = apparent tangential unit-stress, inner surface of inner cylinder,
t_1 = apparent tangential unit-stress, outer surface of inner cylinder,
T_0 and T_1 = corresponding true tangential stresses,
p_0 and p_1 = corresponding apparent radial stresses,
t_2 = apparent tangential unit-stress, inner surface of outer cylinder,
T_2 = corresponding true tangential stress,
p_2 = corresponding apparent radial stress,
P_0 and P_1 = internal and external unit pressures.

Outer Cylinder

In a shrinkage fit, the only important stress in this cylinder is the true tangential stress at the inner surface, where that stress is a maximum. (See Fig. 3). The apparent unit-stresses in the outer cylinder at the inner surface are:

$$t_2 = \frac{P_1(R_2^2+R_1^2)}{R_2^2-R_1^2} \qquad (1)$$

$$p_2 = P_1 \qquad (2)$$

The true tangential tensile unit-stress is:

$$T_2 = t_2 - (-\phi\, p_2) = t_2 + \phi\, p_2$$

* In the present article, the mathematical proof of the formulas given has been omitted, it having been the object to present the data in as practical a form as possible. Those interested in the theoretical treatment are referred to MACHINERY'S Reference Series No. 89, "The Theory of Shrinkage and Forced Fits—With Tabulated Data and Examples from Practice," which will be published shortly. For further information previously published on this subject, see MACHINERY, July, 1909, "Machine Shop Practice—Shrinkage and Forcing Fits," and also MACHINERY'S Data Sheet Series No. 7, "Shafting, Keys and Keyways," pages 28, 29 and 31.

† Address: Gwynedd Valley, Pa.

$$T_2 = P_1\left(\frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \phi\right) \tag{3}$$

Inner Cylinder, Hollow

This cylinder corresponds to a hollow shaft forming the inner member of a shrinkage fit. The stresses to be found are the true tangential stress at the outer surface, which is required to determine the allowances, and the similar stress at the inner surface, since the tangential stress in such a cylinder is compressive and reaches its maximum at the bore (See Fig. 4).

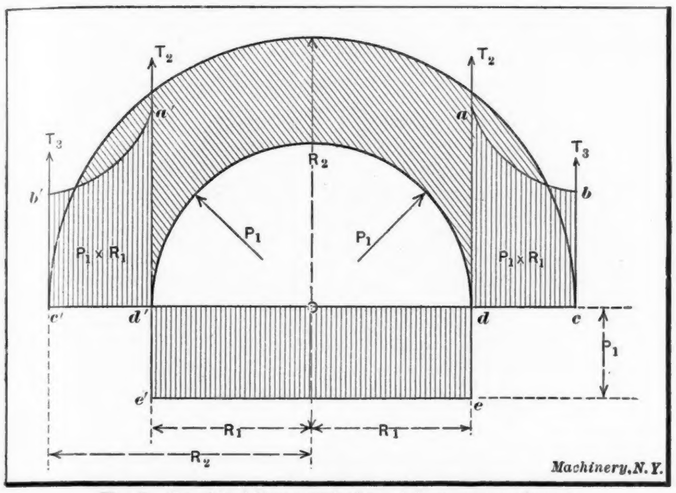


Fig. 3. Graphical Representation of Stresses produced by Shrinkage Fits

The apparent unit-stresses in the inner cylinder at the outer surface are:

$$t_1 = -\frac{P_1(R_1^2 + R_0^2)}{R_1^2 - R_0^2} \tag{4}$$

$$p_1 = P_1 \tag{5}$$

The corresponding true tangential compressive stress is:

$$T_1 = -P_1\left(\frac{R_1^2 + R_0^2}{R_1^2 - R_0^2} - \phi_1\right) \tag{6}$$

For the inner surface the apparent stresses are:

$$t_0 = -P_1 \times \frac{2R_1^2}{R_1^2 - R_0^2} \tag{7}$$

$$p_0 = 0 \tag{8}$$

The true tangential compressive stress is:

$$T_0 = t_0 = -\frac{2P_1R_1^2}{R_1^2 - R_0^2} \tag{9}$$

which is evidently greater, numerically, than T_1.

Inner Cylinder, Solid

If the inner cylinder be solid, the conditions will correspond with those of a solid shaft forming the inner member of the fit. The only stress of importance is the tangential stress at the outer surface, which is required in determining the allowances.

The apparent stresses at the outer surface are:

$$t_1 = -P_1 \tag{10}$$

$$p_1 = P_1 \tag{11}$$

The true tangential compressive stress is:

$$T_1 = -P_1(1 - \phi_1) \tag{12}$$

The values given in Equations (10), (11), and (12) are valid for any point between the outer surface and the center of a solid shaft. In general, in a solid shaft subjected to a uniform external radial pressure, the true radial and tangential compressive stresses are equal at all points, and the intensity of each is uniform throughout.

Formulas for Stresses in the Hub

As shown in Fig 3, the tangential tensile stress in the hub reaches its maximum at the inner surface and decreases rapidly from that surface outward. The true stress at the bore is therefore of primary importance, since the metal is under its greatest stress there. This stress must not exceed the elastic limit, and is one of the factors which determine the "grip" of the fit.

Let D_1 = nominal internal diameter of hub,
D_2 = nominal external diameter of hub,
ϕ = 1/3 for steel and 1/4 for cast iron.

Substituting in Equation (3):

$$T_2 = P_1 \times \frac{4D_2^2 + 2D_1^2}{3(D_2^2 - D_1^2)} \text{ for steel,} \tag{13}$$

$$T_2 = P_1 \times \frac{5D_2^2 + 3D_1^2}{4(D_2^2 - D_1^2)} \text{ for cast iron.} \tag{14}$$

Regarding the stresses in the hub, the following laws hold true:

It is impossible for the shrinkage-load on the hub to burst that member, so long as the true hoop stress T_2 at the bore does not exceed the ultimate tensile stress of the metal.

No unsupported cylinder can be made thick enough to withstand an internal pressure per square inch which is as great as, or greater than, the ultimate tensile strength of the metal.

If the internal pressure P_1 is equal to or greater than the sum $T + 2P_2$, of the ultimate strength and twice the external pressure, no thickness, however great, will enable the cylinder to resist the pressure.

With regard to the possible intensity of shrinkage stresses, it should be borne in mind that shrinkage fits are usually made on the working parts of machines, and hence that the stresses due to shrinkage may be increased by others developed by the external forces applied to the member when the machine is in operation. In such cases, the total stress which will exist at any time should be considered in determining the shrinkage-allowances.

Table I gives values of ratio $A = \frac{P_1}{T_2}$ for various diametral ratios. This ratio will be found of value later in computing shrinkage-allowances. If the true tangential stress T_2 is known or assumed for any of the diametral ratios tabulated, the intensity of P_1, and hence the resistance of the fit to slip may be found by multiplying T_2 by the corresponding value of A.

TABLE I

Values of Ratio A.

Ratio of Nominal Diameters of Hub, $\frac{D_2}{D_1}$	Ratio $A = \frac{P_1}{T_2}$ Steel ($\phi = \frac{1}{3}$)	Ratio $A = \frac{P_1}{T_2}$ Cast Iron ($\phi = \frac{1}{4}$)	Ratio of Nominal Diameters of Hub, $\frac{D_2}{D_1}$	Ratio $A = \frac{P_1}{T_2}$ Steel ($\phi = \frac{1}{3}$)	Ratio $A = \frac{P_1}{T_2}$ Cast Iron ($\phi = \frac{1}{4}$)
1.5	0.341	0.351	2.8	0.615	0.648
1.6	0.382	0.395	3.0	0.632	0.666
1.8	0.449	0.466	3.2	0.645	0.682
2.0	0.500	0.522	3.4	0.657	0.695
2.2	0.539	0.565	3.6	0.666	0 706
2.4	0.570	0.599	3.8	0.675	0.715
2.6	0.595	0.626	4.0	0.682	0.723

Formulas for Stresses in the Shaft

The radial and tangential stresses in the inner member are both compressive. To both, the same principle applies: Each is a measure of the deformation in its direction only at the point where the given intensity of stress exists. If, for example, the radial stress varies from the circumference to the center, its intensity at any given point will not measure the deformation of the entire radius of the member, but only the amount of deformation at the point considered. The only stress which will cover both cases—solid and hollow shafts—and give the reduction in the external diameter of the member, is, therefore, the true tangential stress at the outer surface, since the circumference of that surface and its diameter must decrease together. As with the hub, the nominal diameters may be substituted for the corresponding dimensions of the compressed shaft.

Let D_0 = nominal internal diameter of hollow shaft,
D_1 = nominal external diameter of hollow or solid shaft,
$\phi_1 = 1/3$ for steel and 1/4 for cast iron.

Solid Inner Members

Equation (12) gives the true tangential stress at the outer surface. From that equation:

$$T_1 = -2/3\,P_1 \text{ for steel} \tag{15}$$

$$T_1 = -3/4\,P_1 \text{ for cast iron.} \tag{16}$$

$$\frac{T_1}{P_1} = 1 - \phi_1 = B \text{ for solid inner members} \tag{17}$$

This ratio is of service in computing the allowances. In a solid shaft, both the radial and tangential stresses are, as mentioned before, uniform in intensity from the outer surface to the center, and are equal at all points.

Hollow Inner Members

Equation (6) gives the true tangential stress at the outer surface. From that equation:

$$T_1 = -P_1 \times \frac{2\,D_1^2 + 4\,D_0^2}{3\,(D_1^2 - D_0^2)} \text{ for steel,} \tag{18}$$

$$\frac{T_1}{P_1} = B \text{ for hollow inner members.} \tag{19}$$

Equation (9) gives the true tangential stress T_0 at the inner surface. From (9) and (18):

$$\frac{T_0}{T_1} = \frac{3\,D_1^2}{D_1^2 + 2\,D_0^2} \text{ for steel.} \tag{20}$$

This expression shows the marked increase in the tangential stress from the outer surface to the bore.

The values of B for hollow steel shafts of various diametral ratios are given in Table II.

Work Done in Compressing Solid and Hollow Shafts

The compressibilities of solid and hollow shafts differ, the solid shaft being the stiffer. In a solid shaft under radial pressure, the radial and tangential stresses are equal at all points, as mentioned, and their intensity is uniform throughout. These relations are shown graphically in Fig. 4, where $Oa = cb = P_1 = t = p$. The diagram $Oabc$, therefore, represents the total apparent tangential stress in one-half of a solid shaft. Since this total stress is produced by the total stress in the left side of the hub, whose tangential value is represented by the diagram $cdef$, the two stress-areas are equal, or $Oabc = cdef = P_1 \times R_1$.

TABLE II

Values of Ratio B for hollow steel shafts of external and internal diameters, D_1 and D_0, respectively.

$\frac{D_1}{D_0}$	$B = \frac{T_1}{P_1}$	$\frac{D_1}{D_0}$	$B = \frac{T_1}{P_1}$
2.0	1.333	3.0	0.917
2.5	1.048	3.5	0.844

For solid inner members, Equation (17), $B = 2/3$ for steel and 3/4 for cast iron.

Now, consider the hollow shaft on the right-hand side (Fig. 4), whose original diameter was sufficiently greater than that of the solid shaft to make the radius R_1 of the fit and the radial pressure P_1 on the latter the same as before, with the same hub and hub stresses, so that $ghkl = cdef$. The tangential stress increases rapidly toward the bore, where its magnitude is given by Equation (7). The area representing the total tangential stress is $lmnq$, Fig. 4, and, as before, $lmnq = ghkl = cdef = P_1 \times R_1$. The radial stress is no longer uniform as in a solid shaft, but is equal to P_1 at the outer surface, and decreases to zero at the bore [see Equations (5) and (8)].

It will be seen then, that if two shafts—one solid, the other hollow—when subjected to the same external radial pressure P_1, are compressed to the same radius R_1, the tangential stresses in the hollow shaft will be considerably greater than those in the solid shaft. The reason for this increased effect of P_1 on the tangential stress is that the hollow shaft lacks the support of the solid and compressed cylinder of radius R_0 which has been removed at the bore. In the solid shaft, at the layer of radius R_0, there is an outward radial pressure equal to P_1, while, in the hollow shaft, at this radius, the radial pressure is zero. The absence of outward radial pressure P_1 at the bore produces the total apparent tangential tensile stress in the hollow shaft shown by the area $qsvl$, and, if this be deducted from the area $lmnq$, the remainder will be the area $lwxq$, corresponding with that for a solid shaft between the radii R_1 and R_0. The deductions, as above, apply also to the true tangential stresses, which are the same in kind as the apparent stresses, although differing in intensity.

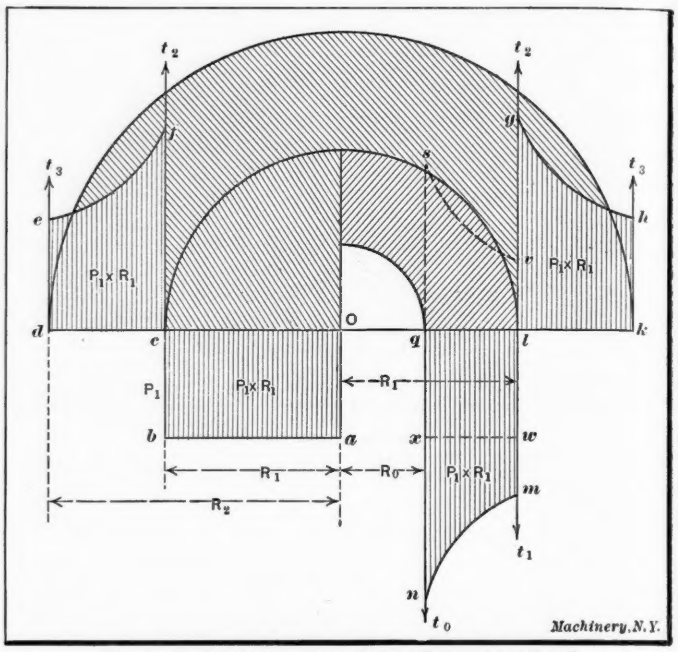


Fig. 4. Graphical Representation of Stresses produced by Shrinkage Fits

Effect of Lateral Contraction

In the outer member of a shrinkage fit, lateral contraction increases the apparent radial and tangential stresses, each by an amount equal to one-third for steel, so that the true stresses are that much greater. In the inner member there is the same proportionate, but reverse, effect, which acts to reduce the intensity of the direct stresses. This action also develops secondary longitudinal stresses in both members, which, however, are negligible in a shrinkage fit.

Example of Use of Formulas

As an extreme example, take a steel hub shrunk on a solid steel shaft, the external diameter of the hub being 1.5 times that of the shaft. Let the shrinkage allowances be such as to produce a true tangential tensile stress of 30,000 pounds per square inch at the bore of the hub. From Table I we find that the unit radial pressure on the fit is 10,230 pounds. Applying the formulas in the foregoing, we have:

	Apparent Stress	True Stress
Hub at Bore:		
Tangential tensile stress	26,598	30,000
Radial compressive stress	10,230	19,096
Shaft at Outer Surface:		
Tangential compressive stress	10,230	6,820
Radial compressive stress	10,230	6,820

The stresses given in the table above were calculated as follows:

The true tangential unit stress T_2 at the bore of the hub, is 30,000 pounds, the ratio of the hub diameters is $\frac{R_2}{R_1} = 1.5$; from this ratio, $R_2^2 = 2.25\,R_1^2$. From Table I, when $R_2 \div R_1 = 1.5$, with both members of steel, ratio $A = 0.341$. Hence

$$\frac{P_1}{T_2} = \frac{P_1}{30{,}000} = 0.341$$

$P_1 = 30{,}000 \times 0.341 = 10{,}230$ pounds = unit radial pressure.

Hub at bore.—The apparent tangential tensile stress is:

$$t_2 = \frac{P_1 (R_2^2 + R_1^2)}{R_2^2 - R_1^2} \qquad (1)$$

Substituting the values of P_1 and R_1:

$$t_2 = 10{,}230 \times \frac{3.25}{1.25} = 26{,}598 \text{ pounds.}$$

The apparent radial compressive stress is:

$$p_2 = P_1 = 10{,}230 \text{ pounds.} \qquad (2)$$

The factor of lateral contraction ϕ, for steel, is $\frac{1}{3} = 0.333$.

The true tangential stress is:

$$T_2 = P_1 \left(\frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \phi \right) \qquad (3)$$

$$= P_1 \left(\frac{3.25}{1.25} + 0.333 \right) = 30{,}000 \text{ pounds.}$$

The true radial stress is:

$$P_2 = P_1 \left[1 + \frac{\phi (R_2^2 + R_1^2)}{R_2^2 - R_1^2} \right]$$

$$= 10{,}230 \left(1 + 0.333 \times \frac{3.25}{1.25} \right) = 19{,}096 \text{ pounds.}$$

Shaft at outer surface.—The shaft is solid. The apparent tangential (compressive) stress at the outer surface is:

$$t_1 = P_1 = 10{,}230 \text{ pounds.} \qquad (10)$$

The apparent radial (compressive) stress is:

$$p_1 = P_1 = 10{,}230 \text{ pounds.} \qquad (11)$$

The true tangential stress is:

$$T_1 = P_1\ (1 - \phi_1) = 10{,}230\ (1 - 0.333) = 6820 \text{ pounds.} \qquad (12)$$

The true radial stress is:

$$P'_1 = P_1\ (1 - \phi_1) = 6820 \text{ pounds.}$$

It will be seen that the use of the apparent, in place of the true, stresses introduces errors which, with regard to the hub, may be serious even in less extreme cases than the above.

Resistance to Slip

The resistance of the fit to slip is theoretically equal to the product of the area of the contact-surface times the unit radial pressure on that surface times the coefficient of friction.

Let D_1 = nominal diameter of fit,
L = length of fit,
P_1 = unit radial pressure on fitted surfaces,
f = coefficient of friction,
Q = total resistance to slip.

$$\text{Then } Q = \pi D_1 \times L \times P_1 \times f \qquad (21)$$

Since slip begins with the parts at rest, the coefficient of friction for rest applies in computing the initial resistance. There is considerable variation in the values given for this coefficient. Reuleaux and Weisbach use 0.2. Rennie, in experiments on metals usually unlubricated, found the following values for f:

Wrought-iron on cast iron	0.28 to 0.37
Steel on cast iron	0.3 to 0.36

In experiments undertaken by Professor Wilmore the average value of this coefficient was 0.102 for cast-iron disks either forced or shrunk on steel spindles. The shrinkage fits were found to be 1.5 times, and the forced fits 1.3 times, stronger in torsion than in tension. This result was to be expected, if the resistance measured was not that to initial slip only, since, in torsion, the grip is undiminished during progressive slipping, while, in tension, the area under pressure decreased steadily as the spindles left the disks.

Let P = force acting to twist a solid shaft,
p = lever arm of P,
J = polar moment of inertia of shaft,
c = distance of most remote fiber of shaft from axis of latter,
S_s = shearing stress at distance c = maximum unit shearing stress,
D_1 = diameter of shaft.

Then:

$$P \times p = S_s \times \frac{J}{c} = S_s \frac{\pi D_1^3}{16}$$

and from equation (21):

$$\frac{QD_1}{2} = \pi D_1 L P_1 f \times \frac{D_1}{2}$$

Taking P_1 and S_s as constant, and equating, we have $L = KD$, in which K is a constant. Therefore with a constant radial pressure, the length of the hub should vary as the diameter of the shaft, in order to make the grip of the fit proportional to the torsional strength of a solid shaft. For both practical and theoretical reasons, it is impossible to make the grip equal to this strength. Hence, with diameters of 2 inches and upwards, keys should be fitted in addition.

* * *

MACHINE TOOL DEFINITIONS*

By OBERLIN SMITH†

It is currently reported that when Adam's descendants became rather numerous, he proceeded to give them each a name. We learn from Holy Writ that he had already named the animals; hence, he appears to have been the first industrial organizer. He probably also gave names to such buildings and tools as he may have accumulated. We do not know what these began with unless, perhaps, a pan for baking the apples that his wife procured for him, and a step-ladder that he might peep back over the wall after he retired from his estate. Thus, doubtless, began the first dictionary-making, for if things had names, these names, by reasoning backwards, of course had definitions.

The writer has sometimes thought that it would be a task of pleasurable excitement to build a mechanical dictionary. The more, however, he has studied the vagaries of human language, particularly English, with its numerous synonyms, and with certain words having several meanings, the less he feels inclined for such a task and the more pure joy there is in the idea that some other fellows will have the task to accomplish.

The recent discussions, extending back through months and even years, upon the meaning of the term "machine tool" would seem to indicate that even one correct definition requires much study and research and that after all this we cannot expect to perfectly define something that is so indefinite in the minds of so many people.

Referring to the article by Mr. Bentley on page 378 of MACHINERY for January, engineering edition, the definition marked *A* obviously does not define, while *B* is too long and yet incomplete. The definition *C* has already been proposed in this country and has been seriously considered by some of the tool makers, at any rate, as the basis for something better, and may therefore be worthy of a brief analysis. It reads as follows: "A machine tool is any hand- or power-driven unitary mechanism actuating cutters, tools, dies or other forming or shaping implements, to perform any process or operation in making tools, machines, structures or any part thereof from metal, in distinction from one for producing a special or specific article."

It is not necessary to speak of the kind of *power* and the act of *driving*, as the term "machine" itself embodies these ideas. Neither is it necessary to say that it is *unitary*, because the name itself is in the singular number. It is not necessary to limit its operation to *metal* because it is often used upon other substances; nor should it be limited to performing *general* work rather than *special*. If we do this, we would throw out car-wheel borers, special axle-lathes, driving-wheel lathes, and many special multi-spindle drillers, all of which are recognized in the machine tool trade as legitimate products.

Many years ago other limitations existed, machine tools usually being restricted to lathes, planers and drills, or to use a more definite word "drillers," thus not confusing the

*For previous discussion of this subject, see "What is a Machine Tool?" MACHINERY, January, 1911.
†President, Ferracute Machine Co., Bridgeton, N. J.

machine with the tool it uses, as a twist-drill, etc. Now, however, the list has been very largely extended. The lathe class has been amplified with turret lathes, screw machines, pipe machines, vertical boring mills, etc. The planer class now includes shapers and slotters and some special portable planers, etc. The drillers now include radial drills (so-called) together with numerous horizontal boring machines and various kinds of multiple-spindle drills and tapping machines. Milling machines in great variety have come into the market since the writer can remember, and classed among them are the various rotary gear-cutters and also drill-slotters. Analogous in principle to millers, are grinders of various sorts, an abrasive wheel performing the same operation as would a milling cutter with a multiplicity of fine teeth. These, of course, are developments of the old-fashioned grindstone, which in ancient times was the nearest approach to a milling-cutter.

All of the machines in the above groups are but developments from those used in typical old-style machine shops. Other personalities more recently admitted to their family are foot-, screw- and power-presses in an almost infinite variety of sizes and designs, which are used for punching, shearing, cutting, forming, bending, drawing, redrawing and coining materials of numerous kinds, generally metals. Almost any of these machines can be made to do, and are often used for, similar work to that of a slotting-machine. It is true that shearing and punching is not exactly similar to the paring off of chips, although in some cases where a little scrap is sheared from the edge of a plate, or where a rough hole is re-punched or drifted, the operation is really exactly the same.

A logic which admitted these presses to the machine tool family of course, when carried further, was obliged to include another tribe of cousins, such as hydraulic presses, drop presses, steam hammers, power hammers, etc. Some of these machines are used for forcing operations such as putting on car-wheels and so forth, but these are only amplifications of the old-fashioned arbor presses long ago used in many shops.

Still later on, various forms of rolling machines seem to have been admitted into shop fellowship, especially straightening- and bending-rolls of both the horizontal and the vertical types. These, together with some of the more plebeian shearing and punching machines, have doubtless been allowed to associate with their more aristocratic brethren on account of their being needed in boiler shops, which are often so closely associated with machine shops. Especially is this the case where such machines as portable engines, etc., are produced.

In recent years other outrages have been perpetrated upon the feelings of old-fashioned machinists by thrusting upon them electric and pneumatic cranes and also air compressors to operate chipping hammers and other pneumatic tools, all as a part of the regular shop equipment. Furthermore, special steam engines and electric motors have been so combined as integral parts of some of the machine tools as to rank them commercially with the more legitimate factors of a modern plant.

A still greater innovation, to which all machine tool men are not yet reconciled, is the admission of wood-working tools within the sacred precincts heretofore devoted to metal working only. There is, however, no logical reason why machines for turning, planing, drilling and sawing woodwork, and which nowadays are built with very much the same appearance as their fellow iron-workers, should not all be placed in the same general class. Some of them indeed closely resemble their more rugged brethren in general design and they can readily be manufactured in the same shop and with the same tools as are the others.

Glancing over the large catalogues (almost dictionary size) of three of the largest machine tool dealers in this country, we find in two of them all sorts of woodworking tools, and in all three of them the various other machines mentioned in this article. Some of them also show a variety of other things of doubtful classification, such as blowers, pumps and those articles which might, perhaps, be regarded as transmission machinery, along with shafting, belting and similar apparatus.

From the foregoing, it would seem that we need to take a general view and contrive a very comprehensive definition for the compound word in question. A natural answer to the question: "What are machine tools?" asked of any intelligent layman, might well be: "Machines and tools used in a machine shop." The definition of this latter term might logically be: "A shop in which machines are made." Shop, in this connection, of course means a building, or any apartment thereof, in which mechanical work is performed. Considering, therefore, that the great variety of articles listed by the dealers referred to allows us much latitude, we are perhaps justified in treating the compound word philologically and combining the definitions of a machine and a tool, the one actuating the other.

Again we have trouble in getting any definite meaning from our indefinite English language. Looking for the meaning of "machine," we find it in the Century Dictionary to be:

"In mechanics, in general, any instrument for the conversion of motion."

In the Standard Dictionary we find it:

"Any combination of inanimate mechanism for utilizing or applying power."

And Webster's Dictionary puts it:

"In general, any combination of bodies so connected that their relative motions are constrained, and by means of which, force and motion may be transmitted and modified."

For a definition of the word "tool," we have in the Century Dictionary:

"A mechanical implement; any implement used by a craftsman or laborer at his work; an instrument employed for performing or facilitating mechanical operations by means of percussion, penetration, separation, abrasion, friction, etc., of the substances operated upon, for all of which operations various motions are required to be given either to the tool or to the work."

The Standard gives it:

"A simple mechanism or implement, as a hammer, chisel, plane, etc., used in working, moving or transforming material."

In Webster's, "tool" is defined as:

"An instrument, such as a hammer, saw, plane, file and the like, used in the manual arts to facilitate mechanical operations."

The term "machine tool" is said by the Century Dictionary to be:

"A machine driven by water, steam, or other power, for performing operations formerly accomplished by means of hand-tools, as planing, drilling, sawing, etc., and taking its special name from the kind of work performed, as planing-machine, drilling-machine, etc."

The Standard gives the definition thus:

"A machine for doing work with cutting tools, or one using minor tools in performing the actual work."

In Webster we find it:

"A machine for cutting and shaping wood, metals, etc., by means of a tool, especially a machine, as a lathe, planer, drilling-machine, etc., designed for a more or less general use in a machine shop in distinction from a machine for producing a special article as in manufacturing."

As usual, "the doctors disagree." The writer, as a layman in dictionary building, suggests some definitions as follows:

MACHINE, *A structure of multiple parts one or more of which have predetermined motions relatively to the others.*

TOOL, *An implement for measuring, handling or altering the shape of various objects.*

MACHINE TOOL, *A machine guiding and actuating tools, such as cutters, dies and other shaping implements, to perform processes or operations in the making of machines and other structures.*

* * *

The fireproof qualities of reinforced concrete construction were well demonstrated in a fire which recently occurred in the coal storage bins in the sub-basement of a large drygoods warehouse in Minneapolis. One day a strong odor of gas was noticed in the building; investigation proved that it came from the sub-basement where the coal was stored. It was found that the entire storage of coal, amounting to about 225 tons, was burning and had probably been burning for some days without perceptibly damaging the reinforced concrete partition walls or ceiling which formed the storage bins. The fire could not be extinguished until the coal was removed.

FILE-MAKING AT A SHEFFIELD WORKS*

By JOSEPH G. HORNER†

The earliest files were made of certain fish-skins; and even to this day some old-fashioned carvers use the skins of the dog-fish to smooth their work. In the prehistoric age, files of bronze were used, and in the Bible, 1 Samuel XIII, 21, mention is also made of files, for we read: "They had a file for the mattocks, and for the coulters, and for the forks, and for the axes, and to sharpen the pads." Steel files are of considerable antiquity; in the Eighteenth Century French Encyclopædia, there are numerous files illustrated which differ in no respect from the Sheffield products of to-day except that they are not finished quite so well. The Swiss files used by watchmakers and jewelers have for a long period enjoyed a high reputation.

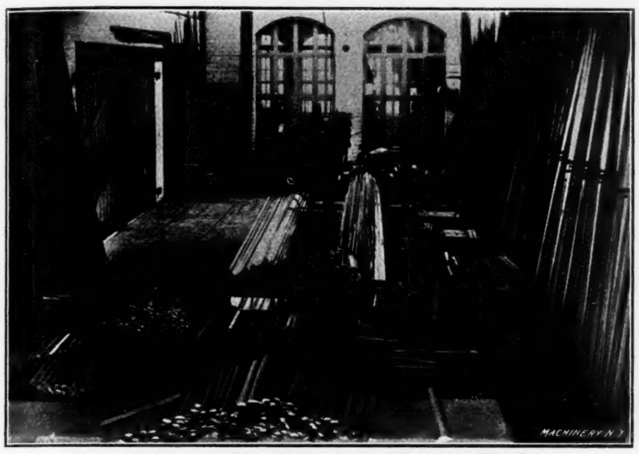


Fig. 1. Cutting the File Blanks in the File-steel Warehouse, preparatory to Forging

Formerly nearly all files were cut by hand, and, in fact, this was the practice in the early days of men who are even now only middle-aged. But at present more than ninety per cent of the files made are machine cut. Although this is a recent development, the idea of machine cutting is by no means new. A file-cutting machine is described in a French work dated 1740; Raoul, a Frenchman, at the close of the eighteenth century, cut files by machine, and Captain Ericcson patented a machine in 1836, which was used by T. Turton & Sons, of Sheffield.

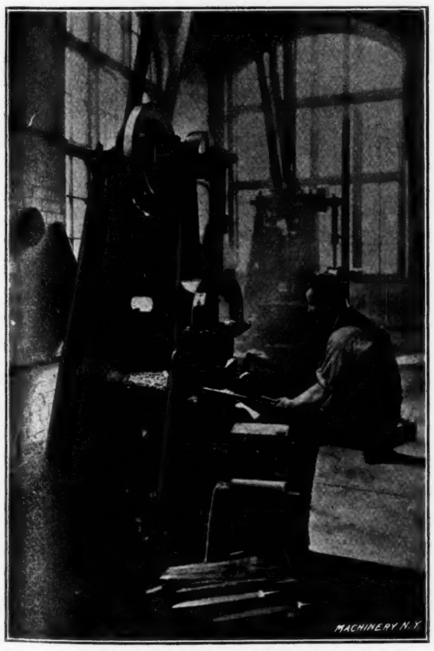


Fig. 2. Forging the Blanks by Quick-action Power Hammers superseding the Old Hand Method

The prejudices of users as well as those of the trade were for a long time almost wholly in favor of hand cutting, so that, a few years ago, in 1886, some of the Sheffield file makers put the question to the test. They had a number of files made, one side being cut by hand, the other by machine. Both of the trade interests were represented during the cutting and the hardening. Private marks were placed on the files, and they were distributed among firms located outside Sheffield, in Leeds, Manchester, Birmingham and elsewhere, with requests to use them and make a mark on the tang of each file on the side which they considered the better. No firm was informed as to which side was hand and which was machine cut, nor as to the nature of the contest. When the reports which came in giving results on cast- and wrought-iron, steel, and brass were collated, it was found that the averages proved nearly equal. The numbers were in the relation of ten in favor of machine cut, eight for hand cut, and five equal. Apprentices are no longer put to the trade of hand file-cutting, while girls can and do operate the smaller machines. A small portion of files are, however, still cut by hand; and since considerable sections of the manufacture involve processes which are not affected by the differences in cutting it may be interesting to offer some account of the older and the present practices.

Fig. 3. Annealing the Files previous to Grinding and Cutting

Fig. 4. Grinding by Hand, now superseded by Machine Grinding

The accompanying halftones represent the stages of the work of file-making as it is carried on by Messrs. Samuel Osborn & Co., Ltd., Sheffield, England. These illustrations are of further interest from the fact that the Clyde Steel Works of Messrs. Osborn is the home of the famous Mushet self-hardening steel. At the same works a new brand of Mushet high-speed steel is now made as a rival to other

Fig. 5. Grinding by Machine, which takes the Place of the Older Method, giving Truer Surfaces

* For additional information on this subject, see the following articles published in MACHINERY: "Toolmaker's Files", January, 1911; and "Making Swiss Files in America," September and October, 1907.

† Address: 45 Sydney Buildings, Bath, England.

high-speed steels. The name of Robert Forester Mushet is familiar to students of the Bessemer process, for it was he who suggested the addition of manganese after the blow.

Sheffield is the Mecca of steel makers. It had achieved a reputation before Creçy and Agincourt. The English arrows of Sheffield manufacture "were so sharp that no armor could repel them." A Government order is on record of 5000 arrowheads at 15 pence per hundred. Chaucer, in "The Reeves Tale," describing the miller, (the "meller") says: "A Scheffeld thwitel bar he in his hose." (A thwitel is a whittle, or whittling knife.) And Sheffield in the fullness of time became the home of the cementation and the Bessemer and Siemens processes. From 1000 to 1500 tons of crucible cast-steel are now melted weekly in its furnaces.

Fig. 6. Stripping Smooth Files by Hand, a Method adapted for Fine Files to obtain an absolutely Level and Smooth Surface

Mushet steel was the result of an accidental discovery. In 1868 Robert Mushet found that a trial bar became hard after being heated without quenching in water. This property was found to be due to the presence of tungsten. In 1871 he became associated with the late Samuel Osborn, who took over the manufacture and sale of "R. Mushet's special steel," as it was called. Lathe and planer tools of this material were found to do two and three times the work of the ordinary carbon tools, and to endure much longer.

The next stage came with the introduction of the high-heat treatment of the steel manufactured by the old process. Mushet high-speed steel is now used for the same purposes as other high-speed steels, but requires different treatment from the original brand. It is forged at a good yellow heat, and is hardened at a white welding heat (2282 to 2372 degrees F.), and blown cold immediately in a blast of air. Twist drills, milling cutters, and reamers, as well as lathe and planer tools are made of high-speed Mushet steel.

Fig. 7. File-cutting by Machine, producing True and Accurately Formed Teeth

The operations of this firm are carried on at three distinct works in Sheffield: The Clyde works, the original home of the Mushet steel manufacture, where crucible steels are melted, hammered and rolled; the Brookhill works where files alone are made, being turned out at the rate of about 43 tons per month; and the steel foundry at the Rutland works, where all kinds of castings from a few ounces to ten tons are produced. The steel used for the files is melted in crucibles, cast into ingots, hammered and rolled into bars at the Wicker works and thence brought to the file steel stores at the Brookhill works. The first stage in manufacture is shearing off the bars to suitable lengths for forging. These are then heated in gas furnaces and forged under spring hammers. Any scale that falls on the anvil is instantly blown away by a jet of air which is constantly blowing over it; otherwise the scale would be hammered into the blank.

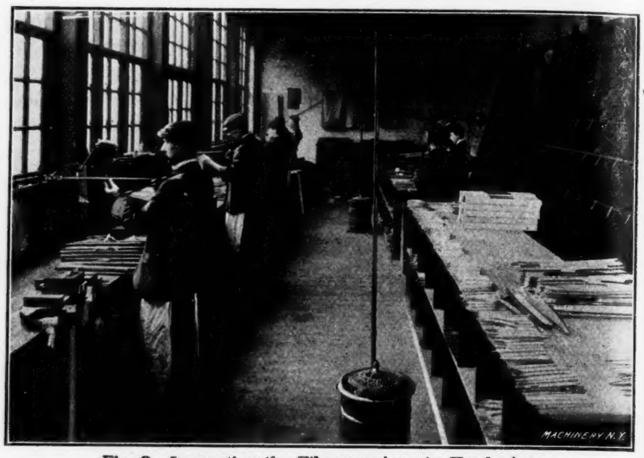


Fig. 8. Inspecting the Files previous to Hardening

Before a file can be cut it must be annealed. Two furnaces are provided for this process, which occupies about twenty-four hours. The cooling-down is gradual, away from contact with the external air. The blanks have now to be ground. The machines used carry stones 5 feet in diameter by 12 inches in width. The files are placed eight or ten in a row and reciprocated under the stone in a water bath, the tangs being held by an iron bar while the points rest on a strip of rubber. A transverse movement is imparted to the grindstone in order to prevent grooving. The tangs are afterwards ground by hand. The foregoing method is only applicable to flat, hand, square, and three-square files; half-rounds and rounds are ground by hand with special hand stones.

Fig. 9. Hardening the Files, a Lead Bath being used for the Heating

The machine-cutting of files is distributed among about sixty machines, which are disposed in three shops. The machine used, the "Weed" patent, is one made by this company for its own service, although it also supplies it to other firms. It is constructed in a range of eight sizes, capable of delivering from 720 to 1280 blows per minute. The head which carries the cutting chisel is inclined at an angle, and the chisel is operated by a camshaft driven by a belt pulley. Two strokes of the chisel are given during each revolution. The "blow" of the chisel is effected by means of the recoil of an India rubber or steel spiral spring, the pressure of which is regulated by means of a screw by a handwheel. The file blank is carried on a bed which fits into a half-round groove

planed in a V-slide, and this bed facilitates the adjustment of the blank in relation to the chisel. There is a presser immediately behind the chisel, which holds down the file and also assists in its adjustment. The V-slide is traversed by a screw. A stop can be set to throw out the action when the cutting is finished and move the driving belt to the loose pulley. One of these machines is designed for cutting the teeth of round files spirally; the difference is that one spiral cut produces the same result as several short cuts in the ordinary fashion.

The files now go into the hardening shops, and are placed vertically in pots containing molten lead (several files being placed in one pot) in which they float. A carbon composition is used to cover the files, and prevent the lead from choking the teeth. The heat is judged by the eye of the workman,

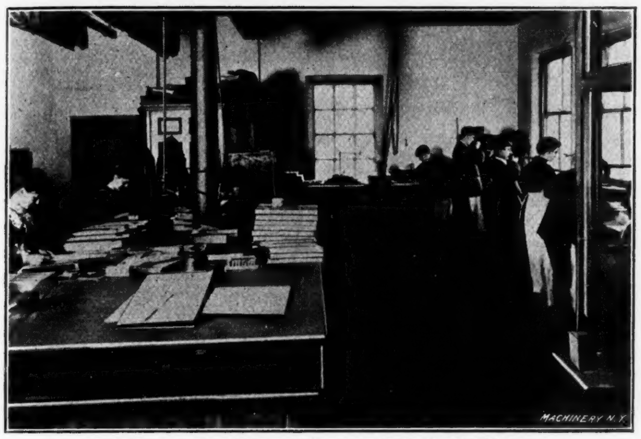


Fig. 10. Proving the Files, and Finally Packing

who, at the right stage, grips a file in the tongs, and plunges it into a saturated solution of common salt. When one file is taken out of the pot, another is placed in. Half-round files, having a variable section in the longitudinal direction, have a tendency to curve in cooling; this tendency is corrected by the hardener, who cambers the files before they are quenched. The half-round back is made concave by as much as 3/8 inch on a 16-inch file. The files are now cleaned off in a sand-blast and then dried, after having been placed in lime-water. Before the day of the sand-blast they were scrubbed by women. The tang is next tempered in another lead bath, and the file is then ready for the last process, *viz.*, brushing over

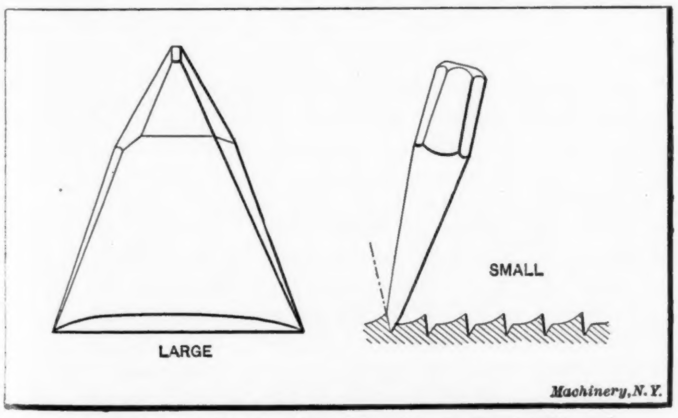


Fig. 11. Type of Chisel used for File-cutting by Hand—Wide and Narrow Examples

with colza oil. The inspection is as follows: First, the files are rung, the inspector judging by the sound if any incipient cracks are present. They are then tested for hardness, which is done by rubbing a round piece of hardened steel, called a "prover" down the teeth. After this they are tested for truth, straightness or flatness, and again for flaws. Finally they are wrapped in paper and packed in cardboard boxes.

It may be of interest here to give a brief statement of the methods of the hand file-cutters in Sheffield and Lancashire as they have been practiced for a century. Much of this work was until recently done in the kitchens of dwelling houses, and the regular shops were a disgrace before official regulations came into force to control them. The large file blanks are ground, and the smaller ones filed to shape, and slightly greased before cutting. The cutter sits before a square stake on which the blank is laid with the tang toward him and the two ends held down by two leather loops which are pressed down by the right foot. Cutting is begun at the point and is done by a very short chisel, the edge of which is slightly blunted to indent rather than to cut the steel. The chisels used are shown in Fig. 11, one about 2½ inches wide for large files, the other about ½ inch wide for small files. The angles of the edges vary, the first being about 50 degrees, and the second 35 degrees. There are also differences in the angles at which the chisels are presented. For rough files, 12 degrees beyond the perpendicular, bastard files, 10 degrees; second-cut files, 7 degrees; smooth-cut files, 5 degrees; and dead-smooth cut files, 4 degrees.

The chisel driven at its angle by the hammer, indents and drives forward the soft annealed steel, throwing up a burr, as shown in Fig. 11. This burr becomes the guide for replacing the chisel for the next cut, and so on. The height of the burr controls the coarseness of the cut, and this is regulated by the force of the blow delivered, a heavier blow producing a higher burr. A file cutter will deliver from sixty to eighty blows per minute. The first course is cut and then the second at a different inclination. The half-round and round files are cut with straight chisels, and require eight or ten courses of cuts to complete them.

To cut opposite faces of a file the face first cut is laid upon a plate of pewter; triangular and round files are laid in corresponding grooves in blocks of lead. During these operations the files usually become bent. They are straightened while at a red heat before being hardened, being heated in a coke fire the temperature of which is adjusted by bellows. Protection is afforded to the teeth by drawing the files through beer grounds or yeast, and then through a mixture of common salt with roasted and pounded cows' hoof. The fusion of the salt indicates that the proper heat for hardening has been reached, which occurs at a cherry red. Just previous to this, at a dull red, the straightening already alluded to is done, across two blocks of lead with the use of a lead hammer. Then, the heat being raised, the file is quenched in water; in the details of this quenching there is room for the exercise of much skill. Before the files are quite cooled, they are corrected by pressure and when straightened are cooled in oil, which prevents them from rusting. The tangs are next softened by grasping them in a pair of heated tongs or by immersion in a bath of lead.

In comparison with these methods the file-cutting machines and the hardeners turn out from twelve to fifteen times the quantity of work that was done formerly in the "day's work" by hand.

* * *

TO PROMOTE DESPATCH OF BUSINESS

The commercial traveler encounters all sorts and conditions of business men from the crabbed stand-offish old school type, that regards all strangers with suspicion, to the modern kind, characterized by cordiality and polite consideration whatever the errand of the suppliant be. "Time is money" and one of the trials of those waiting at the gate is the time they sometimes waste to obtain a five-minute interview. As between the crabbed man who sees you instantly and sends you on your way, and the polite person who makes you wait an hour and then kindly turns you down, the odds are in favor of the first. But it is not always easy to give visitors immediate attention, and sometimes with the best of intentions one may be forgotten in the stress of other urgent business. The following notice posted in the entrance of one large machine tool building concern is intended to encourage the visitor to get his business done as quickly as possible, and is commended for the fine spirit shown:

> If you are not PROMPTLY waited on ring the bell. If you do not promptly see the party you wish to see DO NOT HESITATE to ask for him a second time. While we cannot always see you immediately, we want to save YOU as much time as possible.
>
> GISHOLT MACHINE CO.

LIGHT-WEIGHT ALLOYS FOR AERIAL ENGINES AND AEROPLANES*

It is generally recognized that future improvements in aerial navigation will be greatly facilitated by a decrease in the weight of the machinery. With this end in view metals or alloys of low specific gravity are being eagerly sought to supplant the heavy metals generally in use. The field of investigation, however, is so far very narrow, it being at present limited to the two metals, aluminum and magnesium. The alloys so far developed consist of various proportions of these two elements, modified by small additions of heavier metals.

A number of alloys of this type have been experimented with and several have been patented. The best known are duralum and magnalium. One of the latest discoveries in this line is called duralumin, which is of German origin, as, in fact are most of the light alloys. Extraordinary claims are made for this alloy. It is stated that it has practically all the properties of steel, that it can be drawn, rolled, stamped, or forged, either hot or cold, that its tensile strength ranges from 30,000 to 88,000 pounds per square inch, according to its degree of hardness, and that these qualities are found in an alloy containing from 90 to 95 per cent of aluminum, so that the specific gravity is very nearly that of aluminum.

Duralum contains copper and phosphorus in addition to magnesium. The composition is given as 79 per cent of aluminum, 11 per cent of magnesium, and 10 per cent of phosphor-copper. The percentage of phosphor in the copper is very low—only 0.5 per cent. It is likely that the composition of this alloy, however, is slightly modified in practice, because 10 per cent of copper is exceedingly high, even in the absence of magnesium, and when the hardening effect of 11 per cent of this latter metal is taken into consideration, it would seem that an alloy of the composition as given would be too brittle to be of any practical value.

Magnalium is composed of aluminum and small percentages of magnesium, an analysis showing from 1.58 to 1.60 per cent of this latter element. It also contains small percentages of copper, nickel, tin and lead, the last-mentioned metal probably being an impurity. The specific gravity of this alloy varies from 2.5 to 2.57. According to Prof. J. W. Richards, the tensile strength of magnalium sand castings containing 2 per cent of magnesium is 17,900 pounds per square inch with an elongation of 3 per cent, while with 10 per cent magnesium the tensile strength is increased to 21,400 pounds per square inch, with a 2.4 per cent elongation. It will be seen that the addition of magnesium hardens the metal. Chilled castings of magnalium with 2 per cent magnesium have been found to possess a tensile strength of 28,600 pounds per square inch, with an elongation of 2 per cent, and 10 per cent magnesium alloy chilled castings have a tensile strength of 33,600 pounds per square inch, and an elongation of 3.40 per cent. This is a peculiar condition as compared with that of sand castings. The same peculiarity is found in water-chilled castings, where the 2 per cent alloy has a tensile strength of 40,000 pounds per square inch and a ductility of 1 per cent, while the 10 per cent alloy has a tensile strength of 61,100 pounds per square inch with an elongation of 4.20 per cent.

In another series of light-weight alloys aluminum is replaced by magnesium for the basic metal. This produces a lighter alloy, as the elements of high specific gravity with which the magnesium is alloyed exist only in small proportions. Alloys of this kind contain from 80 to 95.5 per cent of magnesium, the remainder being made up of other metals, principally aluminum. These alloys, it is claimed, can be readily machined, soldered, welded, forged and cast. An alloy of 92 per cent magnesium and 8 per cent aluminum has a specific gravity of 1.75 and is claimed to be equal in strength to the best gun metal, although the metallurgist may doubt this broad statement. The difference in general between gun metal or bronze and the light-weight alloys is that gun metal may combine high tensile strength with great ductility, while the alloys of low specific gravity are more of the nature of cast iron, and high tensile strength is obtained only at the expense of ductility. Various useful magnesium alloys have, however, been produced, such as electron, and ruebel-bronze. These will, no doubt, be found of great value in the construction of aerial machines, but there is a danger of their being discredited by extraordinary claims by the makers which will cause them to be used for purposes for which they are not suited.

There are a number of light-weight metals besides aluminum and magnesium, but there is no likelihood of their being used for practical purposes on account of their scarcity. Among these metals are lithium, rubidium and beryllium. Lithium is the lightest of all metals known, its specific gravity being only 0.57. It possesses, however, but few of the qualities usually associated with metals; it is very soft, and melts at a low temperature, and it is hardly likely that it can be used in sufficient quantity with other metals to appreciably lower their specific gravity in order to produce a light-weight alloy. Rubidium and beryllium, both having specific gravities of from 1.5 to 1.7, are too expensive to be of any commercial value at the present time. The last-mentioned metal has many qualities which would make it a desirable one for aerial work, but the ores of this metal do not occur in sufficient quantities to justify the prophecy that it will ever be used as extensively as aluminum, although this latter metal only a comparatively few years ago also was very expensive. It is, therefore, likely that nearly all investigations relating to light-weight alloys will continue to be based on combinations of magnesium and aluminum with small percentages of heavier common metals.

[In this connection it may be of interest to mention that a Birmingham (England) firm has discovered and patented a new alloy of aluminum which is called *clarus*. It is claimed that this alloy is 60 per cent stronger than aluminum, that its specific gravity is about 3, that castings made from it are not brittle, but can be bent cold, that the castings are free from blowholes and other defects, that it will take a high polish, that atmospheric surroundings do not cause it to tarnish, that it can be made into sheets, drawn into wire, and stamped, and in fact, that practically all operations possible with steel are possible with this metal. Although these claims may have to be accepted with some reserve, it is stated that the alloy has already been put to use in automobile and omnibus fittings in London. The cost of it is said to be but little more than that of aluminum.—EDITOR.]

* Abstract from an article in *The Foundry*, December, 1910.

* * *

The common two-stroke-cycle gas engine is a marvelously simple prime mover. Why has it not displaced the four-stroke-cycle type with its cams, valves, springs, lifters and other details of valve mechanism? Every other stroke of the two-stroke-cycle engine is, or should be, a working stroke, and its power should be theoretically two times that of the four-stroke-cycle engine of the same cylinder dimensions if of equal efficiency. Unfortunately its efficiency is lower at slow speeds and very low when running at high speeds. Many tests made by an engineer—a designer and builder of gas engines—show that the two-stroke-cycle type engine becomes practically a four-stroke-cycle engine at high speeds, every other working stroke failing to fire because of the large percentage of spent gases remaining in the cylinder. The power is cut down and the waste of fuel becomes excessive.

* * *

Contrary to the opinion of the misinformed, the bicycle business is in a flourishing state. The financial condition of the twenty-one concerns making bicycles is generally sound, and the prospects for 1911 business are bright. It is estimated that 600,000 wheels will be made and sold, many, of course, going abroad. The bicycle is no longer a fad; it is used generally for business—the necessary going to and fro of the multitude—and therefore, the enormous number in use is not so apparent, as eighteen or twenty years ago when the streets and roads swarmed with pleasure riders.

TURNING SHAFTS IN THE CLEVELAND PLAIN AUTOMATIC

A shaft-turning operation that is a striking example of the efficiency of automatic machine tools on work within their range, is shown in Fig. 1. The shaft illustrated is known as an "automobile countershaft," and all the operations indicated are performed in from seven to ten minutes, there being a difference in time because of a variation in the carbon content of the steel, which in some cases is 0.25 per cent, and in others from 0.40 to 0.50 per cent. This work is done in a Cleveland "automatic" of the plain type (built by the Cleveland Automatic Machine Co., Cleveland, Ohio), which, as those familiar with this machine know, has a single spindle and no turret. As will be noted by referring to Fig. 1, this shaft, (which is about 10 inches long), has a number of different diameters and shoulders, and a collar near the center. As the diameters decrease on the spindle side of the collar, the tooling arrangement which enables the work to be machined in the time specified and within a limit of 0.003 inch, is one of especial interest.

The general arrangement of the tools for performing the different operations is shown in the plan view, Fig. 2. The tools for turning diameters *a*, *b*, and *c* and centering the outer end of the work, are carried in a box-tool to the right; tool *A* finishing diameter *a*, tool *B* diameter *b*, and tool *C* diameter *c*. The end of the work is centered by tool *H* and chamfered by tool *U*. While the box-tool is at work, the stock is supported by steadyrest *I*. The diameters *e*, *f* and *g* are finished by tool *E* (Fig. 4), and form-tool *F*, the one being attached to a special overhead slide and the other to a front cross-slide. The latter also carries recessing and chamfering tools *J* and *K*, the arrangement of which is shown more clearly in Fig. 6. These tools are mounted one above the other; the lower tools *J* cut the grooves at the ends of the shoulders, for grinding purposes, and the tools *K* chamfer the sharp corners.

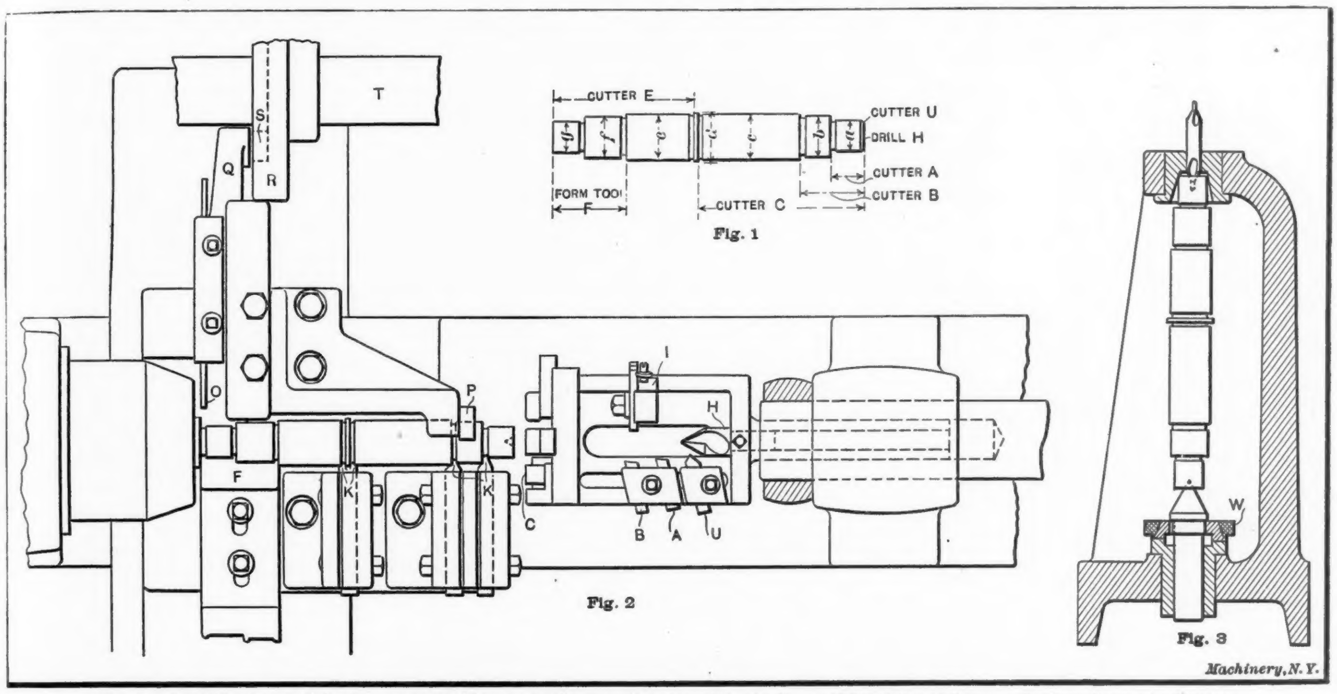


Fig. 1. Steel Shaft turned in from 7 to 10 Minutes in Cleveland Automatic, the time required depending on Carbon Content of Steel. Fig. 2. Plan View showing Arrangement of Tools. Fig. 3. Centering Fixture

The order of the operations is as follows: After the stock has been located by stop *L*, Fig. 5, the box-tool advances until tool *C* reaches the position occupied by tool *E* in Fig. 4. At this point, tool *E*, which is attached to the spindle carrying the box-tool, by connecting-rod *N*, has been sufficiently advanced to bring it into contact with cam *M*, Fig. 5, which feeds it in to the proper depth for turning diameter *e*; then as the box-tool continues to advance, connecting-rod *N* feeds tool *E* forward, thus reducing the stock to diameter *e*, from the central collar to the shaft end, as shown in Fig. 1. When the box-tool and the turning tool *E* have reached the end of their travel, diameters *a*, *b*, *c*, and *e* will have been finished and the end of the work centered. The tailstock spindle then recedes, returning the box-tool and tool *E* to their original

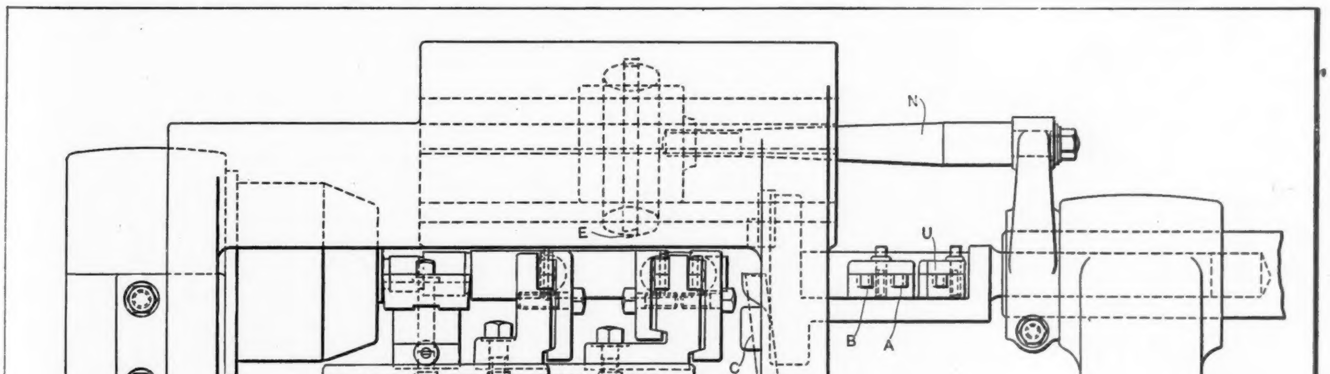


Fig. 4. Front Elevation of Cleveland Machine arranged for Turning Shaft shown in Fig. 1

positions. At this moment, the front cross-slide advances and forming tool *F* begins to remove stock on diameters *f* and *g*; the recessing and chamfering tools *J* and *K* are also brought into operation at this time. Simultaneously with this movement, the rear cross-slide, carrying cut-off tool *O*, and roller steadyrest *P* is moved forward, and the finished piece is severed.

The roller steadyrest supports the end of the work while the forming tool *F* and the recessing and chamfering cutters are at work. Were it not for the necessity of using a steadyrest, the cut-off tool could have been mounted on the regular cross-slide. The use of the steadyrest, however, made necessary a compound slide of special construction. The operation of this slide will be understood by referring to Figs. 1 and 6. The movement of the independent cut-off slide *Q* is derived from cam *R* on cam-shaft *T*; this cam engages a roller *S* attached to the independent slide, which is fastened to the regular slide. The regular slide carrying steadyrest *P* is moved forward by the regular drum cam (not shown) until the rollers are in contact with the work, in which position it is held while the cutting-off operation is being performed by tool *O*, which continues to advance until the work is separated from the bar. From the foregoing it will be seen that this combination steadyrest and special cut-off slide gives support to the end of the piece during the forming and recessing operations, which is absolutely necessary owing to the length of the shaft.

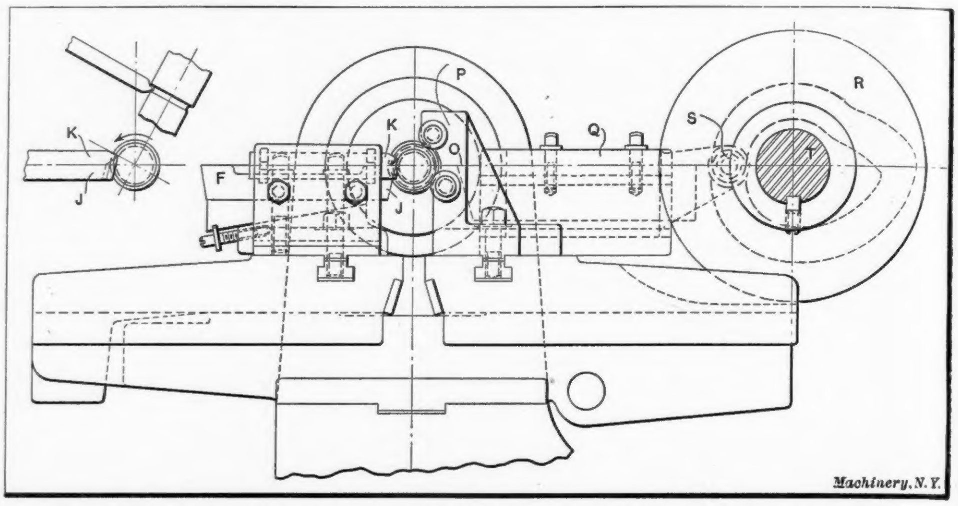


Fig. 6. Side Elevation of Front and Rear Slides for Forming, Steadying and Cutting-off Operations

The method of attaching the special overhead slide to the machine is shown in Fig. 4, one end being bolted to the spindle-head, and the other to the top of the bed. This construction gives the slide the rigidity which is essential for accurate results. In the end view, Fig. 5, the location of the tool with

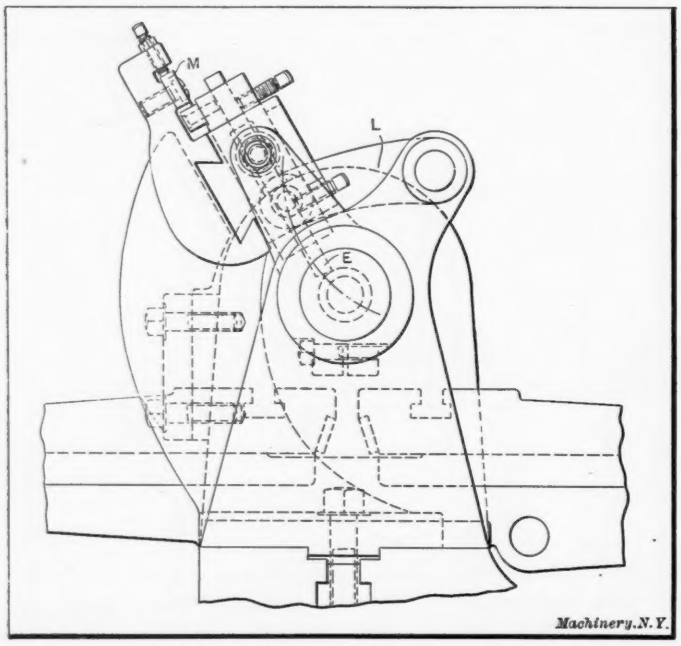


Fig. 5. Side View of Special Overhead Slide

relation to the work and the method of governing its movement, is clearly indicated. This cam or guide-bar *M* is hardened, and the tool-holder is equipped with a roller that comes in contact with the cam, as shown, thus giving the tool a positive inward feed at the proper time.

The cost of producing this shaft when the low-carbon stock is used, is seven mills, whereas the cost per shaft with high-carbon material is ten mills, the time, as before stated, being seven minutes in one case and ten in the other, the difference depending upon the carbon content. When a machine is set up for this work, there is nothing special about the equipment with the exception of the overhead slide and the combined cutting-off and steadying attachment. The box-tool can be used for any purpose within its capacity, and the machine is capable of operating on various classes of work. The holder for the circular tool is a regular design, as is the holder for the flat forming tool. The cost of the machine and tools, the machine being of the plain type, is about the same as the cost of a turret machine for the same job but without tool equipment.

In Fig. 3 a simple and efficient fixture for centering the end of this shaft prior to hardening, is shown. As will be seen, the lower end of the work is supported by a center, and the upper end is accurately located by a conical bushing, having a central hole which guides a combination countersink and drill. As the lower center is supported on a cam surface which gives it a vertical movement of about 3/8 inch, one turn of the knurled collar *W* lowers the center sufficiently to permit the shaft to be inserted or removed. The point of this center has been ground rounding so that it will not mar the end of the shaft in any way. By this simple arrangement, a center is drilled in the blank end with sufficient accuracy for all practical purposes. This type of fixture could also be used to advantage for centering both ends, if this were necessary. When used in this way, the lower center would be replaced by a bushing, cupped out similar to the one at the top. One end of all the pieces would first be centered, after which the lower bushing would be replaced by the center while drilling the opposite ends. By using the cam form instead of a screw for the lower center, a quick action is obtained, and there is the further advantage that the upper bushing cannot be subjected to excessive pressure. This fixture, of course, is intended for centering the shaft illustrated, but it could be adapted to a wide range of work by mounting the center (and bushing when necessary) in a slide having a vertical adjustment.

* * *

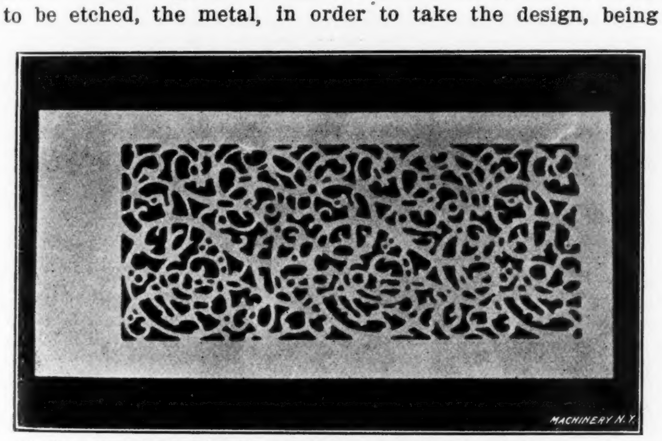
One of the large manufacturers of tapper taps finds it necessary to make up stock with the shank end unfinished because of the large number of patterns of shanks required by certain large users to fit the chucks of their tapping machines. One large corporation alone specifies over twenty patterns of shanks for its various plants. The taps are manufactured, except the shanks which are left blank, and put on the stockroom shelves covered with slushing oil awaiting requisitions. As these come in, the shanks are finished to conform to the requirements of individual orders. In this way the enormous number of combinations required if the taps were completed is avoided. The maker, of course, is helpless to correct the bad practice, but it would seem that the engineers in charge of these large plants would see the folly of keeping tapping machines in use with so great a variety of spindle chucks. The obvious reform would be to adopt a standard chuck and change all spindles to conform. The saving of clerical labor alone in ordering taps, to say nothing of the interest on the investment in taps rarely used, would pay for the change.

ETCHING AS A MEANS OF PRODUCING PERFORATED METAL DESIGNS

When an ornamental design such as shown in the accompanying illustration is to be produced in small numbers, it would not be economical to make dies; at the same time, drilling and filing the holes from a pattern scribed on the surface, is a tedious and expensive undertaking.

Etching is a method of producing a design in metal by eating away the rejected part with a chemical solution. This process it seems is adapted to the production of ornamental metal designs in small quantities when extreme accuracy is not required. According to *The Brass World*, there are four means in common use for preparing the surface of the work to be etched, in which a "resist" or "stopper" is used to cover the surfaces that are not to be etched, leaving the pattern on the plate exposed to the etching acid. The first method—the earliest used—consists in painting the design on the plate with a suitable resist material. This method is costly, involving the drawing of each design separately on the plate. The second, or the rubber-stamp method, is employed on the cheapest class of work, such as etching names on knife blades, and would not be adaptable for the case under consideration, as the etched design is very rough. With the third process—transfer method—the design lacks detail to a marked degree. It is transferred from a steel master plate to the metal, by means of transfer paper, and then etched, the resist being the material transferred. The last and best is the photographic process, the method by which nearly all fine work is done, and which is one peculiarly adapted to the previously-mentioned stamped-metal application.

In the photographic process, the design is first drawn on white paper, to any convenient scale, in black and white. A photographic negative is then made, this being procurable from photo-engravers who make a specialty of such work. The blacks and whites must be respectively, opaque and transparent. This negative is used to print the design on the work to be etched, the metal, in order to take the design, being



Sterling Silver Plate Pierced by Etching, illustrating the Application of the Process to Piercing Metal Plates of All Kinds

coated with a sensitized emulsion of bichromated albumen which has the property of remaining insoluble in water after exposure to light. The portions corresponding to the opaque parts of the negative thus wash out in warm water, leaving the bare metal. Just prior to the washing process, however, the surface is coated by means of a roller, with special lithographic ink. The design is now on the metal in the form of a bichromated albumen base covered with a sticky ink. The resist is further reinforced by sprinkling the whole surface with dragon's blood, and heating to melt the latter. This adheres to the resist already on the surface, but forms in a powder on the unprotected surface, which may be readily blown off. This resist is all right for etching that is not too deep, but for very deep work, special resists are used.

The prepared plate is now ready for the etching process. For brass and copper, a strong solution of perchloride of iron is generally preferred, as this does not attack the resist like strong acids, even though its action is quite slow. Nitric acid may be used with proper resists. While etching is usually only applied for cutting into the surface of the metal, it has been conclusively proved that the same process is applicable to piercing the plate, as shown by the illustration.

SPLICES FOR ANGLES*†

By A. L. CAMPBELL‡

It is often desirable to butt together and splice two angles, and usually the efficiency of the joint must be considered. Data on angle splicing, however, are very scarce, and it is, therefore, hoped that a discussion of this subject will be acceptable to many designers.

In order to splice together two angles of the same size correctly, we must first determine the amount of metal in each leg and the location of its center of gravity, and then we must place a sufficient number of rivets in each leg, symmetrically about its neutral axis, and provide ample metal in the splice plates.

Fig. 1 shows a section of an angle with a 6-inch leg, ¾-inch thick. The total area of this leg is denoted by the shaded por-

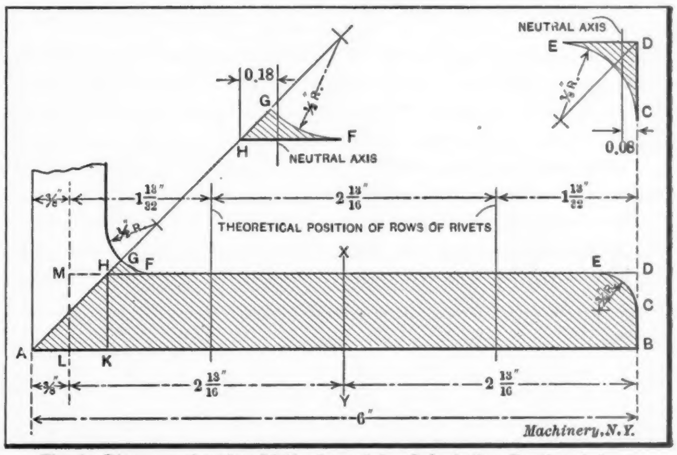


Fig. 1. Diagram showing Method used for Calculating Sectional Area

tion, *ABCEFGHA*, which may be considered as made up of the areas *HAK*, *KBDH*, *FGH*, and the negative area *CDE*. The center of gravity, or neutral axis, *XY* is located by adding the products obtained through multiplying each of the above areas by the distance of its center of gravity from one edge, as *BCD*, and dividing this sum by the total area of the leg. The quotient denotes the distance of *XY* from the edge chosen. If this calculation is carried out, following the dimensions given in Fig. 1, we find that the distance of *XY* from *BCD* is equal to 2.8 inches.

If only the area *ABCDEFHA* (or the equivalent area *LBDM*) is considered, it will be found that the neutral axis is 2.81 inches from the edge *BCD*. This indicates that the positive area *FGH* and the negative area *CDE* practically neutralize each other, and that they may safely be neglected, since the above results differ so slightly. If the leg were thinner, this difference would be a little greater, but in no case would it amount to as much as other errors caused by working conditions.

Having now located the neutral axis of the leg, the rows of rivets in the splice should properly be placed in the middle of each of the two areas into which line *XY* divides the leg. Each row should contain the same number of rivets, to avoid eccentric loading. If only one row of rivets is used in each leg, it should, of course, be located at *XY*. According to this, the two rows of rivets in Fig. 1 would be located 1 25/32 inch and 4 19/32 inches, respectively, from the back of the angle; but this leaves only one-half inch from the inner rivet centers to the edge of the fillet. The rivet heads would, therefore, ride up on the fillet if the rivets were driven from the back of the angle, and it would be impossible to drive them from the trough of the angle with a pneumatic hammer or power press. Hence, this row of rivets must be moved outward to about 2 inches from the back of the angle. If the other row of rivets be moved inward an equal amount, no eccentric loads will be created, and no bending moments will be imposed on the leg, but a small variation of the unit stresses will be created in it.

Splices are shown in the accompanying Data Sheet Supple-

* With Data Sheet Supplement.

† See MACHINERY, November, 1909, engineering edition: "Splices for I-beams and Channels." See also MACHINERY'S Data Sheet Nos. 123 and 125, and MACHINERY'S Data Sheet Series No. 18, "Beam Formulas and Structural Design," pages 36 to 42, inclusive.

‡ Assistant Construction Engineer, The Solvay Process Co., Detroit, Mich.

ment for the most commonly used angles with equal legs, from 8 to 3 inches, and for angles with unequal legs from 6 to 2 inches. In each case, a medium weight section has been chosen, since this will most nearly meet average conditions.

All computations are based on the following working stresses:

Tension or compression.......16,000 pounds per square inch.
Shear ....10,000 pounds per square inch.
Bearing ....20,000 pounds per square inch.

The general method of carrying out the calculations for each of the splices is outlined in the following. The calculation given refers specifically to the 8 x 8 x ¾-inch angle shown in the accompanying Data Sheet Supplement. The area of section of this angle is 11.44 square inches and the sectional modulus is 12.18.

The gross area of either leg is $\frac{11.44}{2}$, or 5.72 square inches. The approximate net area of each leg is found by deducting the area of one rivet hole, and is equal to 4.92 square inches. The allowable tension on this area is 4.92 × 16,000, or 78,720 pounds; and since the shearing resistance of a 1-inch rivet is 7850 pounds, ten rivets are required for each leg. Two 13/16 x 7¾-inch splice plates are used.

The bending efficiency of the rivets in the splice may be found by multiplying the total shearing value of all the rivets in either leg by the distance of their line of action from the

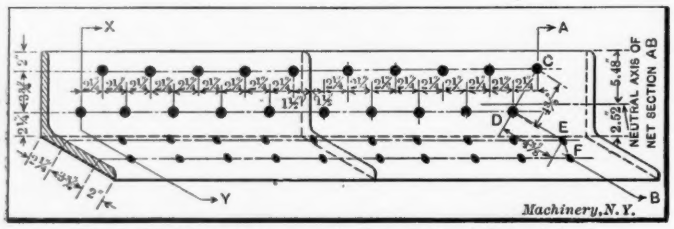


Fig. 2. Rivet Spacing in an 8 by 8 by 3/4-inch Spliced Angle

line of action of those in the other leg; and dividing this product by the allowable bending moment of a gross section of the angle. Since this is equal to the sectional modulus multiplied by the working stress per square inch, we find that the efficiency is equal to 166 per cent.

To find the minimum bending efficiency of the angle at the splice, it is necessary to find this efficiency for the net section *AB* of Fig. 2, which shows the spacing of the rivet holes in the splice. To do so, we must compute the sectional modulus of section *AB* with two rivet holes omitted from each leg. Then the ratio of this sectional modulus to the sectional modulus of the gross section will be the bending efficiency of the section. The rivets in the vertical leg of the angle above the vertical axis of the net section (load applied vertically, acting downward) do not lessen the sectional modulus since they are in compression, and the rivets are assumed to completely fill the holes.

The sectional modulus of the net section is equal to $\frac{\Sigma I + \Sigma C^2 A}{H}$, where ΣI is the sum of the moments of inertia about their own neutral axes, of all the areas into which section *AB* is divided; $\Sigma C^2 A$ is the sum of these areas multiplied, respectively, by the squares of the distances of their centers of gravity from the neutral axis of the net section as a whole; and H is the distance of this neutral axis from the top of the vertical leg. By carrying out the calculations, we find that the value of H, which is determined as in Fig. 1, is equal to 5.44; ΣI equals 12.97; and $\Sigma C^2 A$ equals 61.12. Finally, the sectional modulus of section *AB* is found to equal 13.6, and its bending efficiency is equal to $\frac{13.6}{12.18}$ or 112 per cent.

That the bending efficiency of this net section should be greater than that of a gross section seems like a paradox, but may be explained as follows: The moment of inertia of section *AB*, Fig. 2, is greater than that of a gross section because the diagonal distances *CD*, *DE*, and *EF*, with the rivet holes deducted, were used in its computation; also, the value of H is less than for a gross section, owing to the fact that deducting two rivet holes from the horizontal leg and only one from the vertical leg throws the neutral axis toward the top of the angle, from which point H is measured.

It is now evident that section *XY* of Fig. 2 will give the minimum bending efficiency of the angle. Proceeding as above, we find $H = 5.48$, $\Sigma I = 9.23$, and $\Sigma C^2 A = 57.05$. Its sectional modulus is then 11.55, while the bending efficiency is 95 per cent.

The efficiency of this splice for direct tension is also high. Twenty 1-inch rivets are available in each half of the splice, and their shearing efficiency is 86 per cent. The lowest tension efficiency of the angle is found at section *AB*, and is equal to 84 per cent. The efficiency of the splice plates for tension is equal to 89 per cent.

Below is given a table of efficiencies for angles with equal legs spliced as shown in the Data Sheet Supplement:

TABLE I. EFFICIENCY OF SPLICES FOR ANGLES OF EQUAL LEGS

Size of Angle, Inches	Bending Efficiency, Per Cent		Tension Efficiency, Per Cent		
	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Net Section of Splice Plates
6 x 8 x ¾	166	95	86	84	89
6 x 6 x ⅝	147	98	85	84	87
5 x 5 x ⅝	187	96	94	83	83
4 x 4 x ½	179	97	88	85	88
3½ x 3½ x ½	174	96	85	84	84
3 x 3 x ⅜	187	92	91	85	89

Two sets of values for H, ΣI, and $\Sigma C^2 A$ must be computed for each angle with unequal legs, since it has two values of the sectional modulus. This gives double bending efficiencies; otherwise the treatment is the same as for angles with equal legs.

The bending efficiency of the splice plates has not been computed, since it is always above 100 per cent. The lowest efficiencies are seen to be for the rivets and the net sections of the angles in tension. These efficiencies may be increased if

TABLE II. EFFICIENCY OF SPLICES FOR ANGLES OF UNEQUAL LEGS

Size of Angle, Inches	Bending Efficiency, Per Cent				Tension Efficiency, Per Cent		
	Long Leg, Vertical		Short Leg, Vertical				
	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Rivets	Net Section of Angle	Net Section of Splice Plates
6 x 4 x ⅝	108	95	157	93	83	85	90
5 x 4 x ⅝	117	96	142	98	85	85	92
5 x 3 x ½	100	94	155	96	88	87	90
4 x 3 x ½	124	94	160	96	85	83	84
3½ x 2½ x ⅜	142	94	193	97	92	82	91
3 x 2 x ⅜	120	90	175	92	89	84	90

desired by using smaller rivets, or more of them, or by respacing them; so that the minimum efficiency will be more than 85 per cent. The apparent weakness of the rivets in tension is balanced, however, by their being actually 1/16 inch larger than dimensioned. For a ¾-inch rivet, this difference amounts to 16 per cent.

When one of these splices is used in compression, the gross section of the splice plates and angle should be used in computing its efficiency, while the rivet efficiency will be the same as for tension. If used in a short strut, the shear of the rivets only need be considered; if, however, the splice occurs in a long compression member, its lowest sectional modulus must be used in the column formula chosen instead of the sectional modulus of the gross section, unless the splice is near one end.

Any or all of the rivets in these splices may be countersunk with a slight decrease in efficiencies, due to the extra amount of metal cut away. Either splice plate may be safely omitted if a floor plate, etc., is riveted to the leg of the angle in its place. None of the above splices has ever been tested to destruction. However, a set of similar splices has been used by a large Detroit firm for over two years in their construction work, and often loaded to the full working strength of the angles without any failures.

MANGANESE STEEL*

Manganese steel was first successfully produced by the Hadfields in England about thirty years ago, and was known as "Hadfield steel." It was first made in the United States by the Taylor Iron & Steel Co., of High Bridge, N. J. About five or six years ago other foundries in this country took up its production, but they soon discovered that it was a very difficult metal to produce successfully, and comparatively few foundries are to-day engaged in manganese-steel making. In fact, the manufacture in the United States is almost entirely confined to two companies, the one mentioned above, and the Edgar Allen American Manganese Steel Co. The latter firm has two foundries, one at Chicago Heights, Ill., and one at Newcastle, Del.

We might define manganese steel as a metal of the following composition:

	Per Cent
Manganese	11.00 to 15.00
Carbon	1.00 to 1.20
Silicon	0.25 to 0.40
Phosphorus	0.06 to 0.11
Sulphur	0.02 to 0.06
Balance, iron.	

Variations from the composition given above have been tried, and steel has been made containing anywhere from 8 to 35 per cent of manganese, but commercial manganese steel contains at present about 10 to 15 per cent of manganese and 1 per cent of carbon, these two constituents being the chief factors in manganese-steel making. Great care must be exercised in the manufacture so that the percentages of these two constituents are in the right proportion. Too much carbon and not enough manganese makes the steel brittle.

Manganese steel is considered a very hard metal, because of the fact that it cannot be machined as readily as ordinary iron or steel. In fact, it is practically impossible to machine it with even the highest quality of tool steel. Tests made on the scleroscope indicate a hardness of about 30 for Bessemer steel, from 40 to 50 for manganese steel, and from 65 to 70 for chilled cast iron; yet it has been demonstrated again and again that manganese steel will outwear chilled cast iron many times over. In general, it is safe to say that it will wear from four to eight times as long, depending upon the purpose it is used for and the conditions under which it works. The secret of the resistance of manganese steel to abrasive action seems to be due to its ability to "flow" or endure repeated distortion. Under abrasive action it simply moves away from one place to another, but does not actually wear off. One can take, for example, a square corner of a piece of manganese steel and peen it over, and then pound it back to a square corner, and keep up this operation without actually being able to remove any material.

Manganese steel is very sensitive to heat. A statement given out by the Edgar Allen American Manganese Steel Co. contains some interesting information on this point. Manganese-steel castings should never be heated, because if heated to a temperature of only 400 degrees F., they will lose their toughness and strength to a remarkable degree. This applies to castings of plain design; castings of irregular design do not even stand as high a heat as 400 degrees F. A casting which is in perfect condition and free from internal stresses at the time it leaves the foundry is very likely to break or crack if heated. The company strongly disclaims any responsibility for the breakage of any manganese-steel castings which have been heated after their shipment from the company's foundry.

Manganese steel will not become a permanent magnet; hence it is used for disks in magnetic hoists, as the smallest particle of iron or steel will not cling to it after the current is shut off. The tensile strength of early specimens, determined by Hadfield in England, was 150,000 pounds per square inch, with an elongation as high as 50 per cent. The average commercial steel of to-day, however, has a tensile strength of 82,000 pounds per square inch, an elastic limit of 45,000 pounds and an elongation of 30 per cent. Forged manganese steel will give better results, but there is very little commercial forged manganese steel made at this time.

The manufacture of manganese steel is carried on with a great degree of secrecy, and for this reason full information on some of the processes employed cannot be given. The steel is composed chiefly of a mixture of scrap iron and pig, this mixture being very carefully made up according to the predetermined composition of the steel. The mixture is melted in an ordinary cupola such as is used in any foundry, and is then run into a converter and blown quite similarly to Bessemer steel. This process, however, is carried out with great care and is directed by one man only, who operates everything from the central station or platform close to the converters. After the steel is blown, it is poured into large ladles from which the slag is removed. The manganese, which has previously been melted in graphite crucibles under intense heat, is then added. From the large ladles it is poured into sand molds which are practically the same as ordinary molds for cast iron.

One difficulty with manganese-steel castings is the excessive shrinkage when cooling. Manganese steel shrinks 5/16 inch per foot, which is nearly three times as much as the shrinkage of ordinary cast iron. All ladles and molds are kept very hot so as not to chill the metal before it is poured, as in this case a homogeneous casting could not be produced. After the casting process is completed, the castings are all subjected to a heat treatment, or both heat treatment and water submergence. This part of the process is kept secret by the manufacturers.

Manganese-steel castings can only be successfully made to certain sizes as regards length and particularly as regards cross-sectional area, the thickness being the prime factor. The greatest thickness of any section that has been successfully cast, up to date, is about 4½ inches. It is also very difficult to cast small or thin sections, the lower limit being about ⅝ inch for ordinary castings. The reason that the thickness is so important is because of the after treatment, which apparently will only penetrate to a certain depth. Thin sections are limited by the flow of the metal.

Owing to the fact that manganese steel cannot be cut by ordinary cutting tools, all machining on manganese-steel castings must be done by means of grinding. Sometimes steel bushings and other pieces of ordinary soft steel are inserted in the molds and cast into the casting, making it possible to bore out, drill or tap the casting at certain places. For example, the hubs for car wheels may be provided with soft steel bushings, and soft steel inserts may be provided for set-screws, etc.

The uses of manganese steel are not very extensive at present, due partly to its high first cost, and partly to the difficulty of machining the steel. It is used mostly for castings subjected to heavy strains and shocks and excessive wear, such as the wearing parts of steam shovels, ore and rock crushers, mining machinery, etc. It is also used to a considerable extent for safes. When rolled and forged, it is used for rails, frogs and crossings. The use of manganese steel has made it possible to cut down the maintenance cost for many machines very materially; the effect on the cost of rails in curves and for track with very heavy traffic has been referred to previously in MACHINERY, December, 1908, and June, 1909.

It may be of interest to emphasize the fact that manganese steel has proved itself efficient when used in cases where it is subjected to shocks. An idea prevails among railway engineers that this steel will not stand shocks. As an experiment, therefore, a manganese-steel frog weighing 800 pounds was bent under a drop weight. The frog was subjected to 165 blows from a weight ranging from 1250 to 2500 pounds and falling from a height varying from 3 to 23 feet, the total energy exerted being nearly 1,700,000 foot-pounds. No fracture or impairment of any nature could be discovered. There are hundreds of manganese-steel frogs and cross-overs now in use. At the Northwestern Terminal, in Chicago alone, there are 200 frogs of this kind installed.

* Abstract of paper by Mr. F. E. Johnson, read before the Association of Engineering Societies, October 21, 1910.

NEW METHOD OF METAL COATING

The new method of obtaining metallic deposits, recently discovered and developed by Herr U. Schoop, and which was reported by R. E. Mansfield, U. S. Consul General at Zurich, Switzerland, may be considered the complement of the galvanizing process. The method consists in projecting molten pulverized metal on such surfaces as it is desired to cover with a metallic deposit, the projection of the molten metal being effected by means of suitable nozzles employing certain gases or vapors at high temperatures and pressures. These gases play a double purpose according to the case, either as a purely physical means of pulverization, or as a chemical agent.

The inactive or reducing gases, such as nitrogen or hydrogen are principally adapted to the pulverization of the metal, especially if the metal oxidizes very readily when agitated. Considering the cheapness of nitrogen, which is a by-product in the manufacture of liquid air, it will doubtless be this gas which will be put to the greatest use in the future. However, superheated steam may be employed in certain cases.

The metal coming into the apparatus under pressure is reduced to an impalpable powder, and this being projected violently onto the surface of an article, the particles are deposited in the form of an extremely fine and compact coating, which has the same homogeneity throughout, presenting a fine appearance. The thickness of coating may vary from a thousandth to a considerable fraction of an inch, depending upon the duration of the treatment. It can be seen that the surface does not require to have conductivity, thereby making it applicable to the coating of non-metallic objects as well as metals.

A fact which is striking on first examination, is the low temperature of these metallic vapors, which vary between 50 and 140 degrees F., permitting this treatment to be applied to articles that are readily fusible or inflammable. The pressure of the gas is relatively high, running from 300 to 350 pounds per square inch. The expansion, which is produced at the opening of the nozzle, is principally in consequence of the initial temperature, which is from 400 to 550 degrees F. In consequence of the great pressure of the gas, the metal receives a tremendously high velocity.

The metals which are principally adapted to the Schoop process are those which become very fluid, (tin, lead, copper, aluminum alloys) in the state of fusion; the actual temperature of fusion on the contrary, which is raised more or less to deposit metal, plays only a secondary part. An interesting application of the process in this connection is that of depositing aluminum, which is the only metal now remaining refractory to the galvanic process.

The thickness and physical character of the metal film may vary within considerable limits, depending upon the duration of exposure and the conditions of the parts of the apparatus, such as orifice, nature of the gas used, temperature of fusion of the metal, and its initial pressure, etc. For thin coatings the deposit is made instantly, and for coatings up to 0.25 inch thick, from eight to ten seconds will suffice. The fact that thick coatings can be made has suggested the use of this method for replacing the electrotype process, which is only applicable to conductive surfaces. With a single stereotype negative, as many as 300 reproductions can be made in ten hours, for only a small fraction of the cost of the electrotype reproductions; at the same time they are in no way distinguishable from the latter. It is supposed that the structure of the metal coating by the Schoop process is not crystalline, but that it immediately assumes an amorphous form.

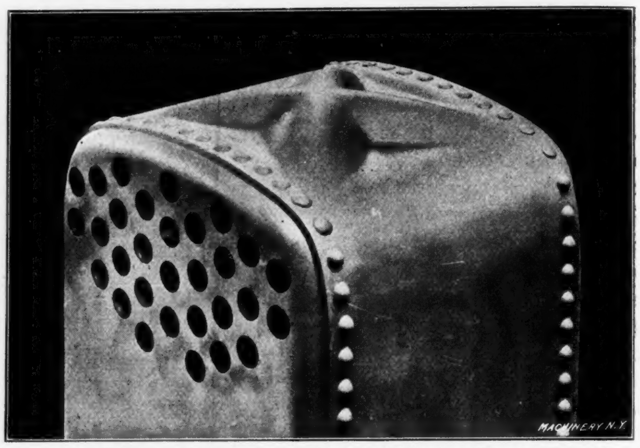
For the industrial application of the process there are two big classes of work to which this can be applied: First, for a permanent coating intended to improve the surfaces as well as to protect them against inclemency and other influences. Under this class come all sorts of metals, as well as plaster, ebonite, glass, paper, wood, celluloid, anatomical pieces, etc. It is even suggested that metal boxes of any desired shape may be made by applying a metal coating of the required thickness to a pasteboard or other pliable form shaped as desired. The second application is for coatings which are to be detached from the surface; these include electrotype impressions, the manufacture of small tubes without solder, and the making of hollow metallic articles. It can be seen from the foregoing that this new invention will tend towards a revolution in some of the industries mentioned.

* * *

ENGLISH FIREBOX TOP FOR SMALL LOCOMOTIVE BOILERS

By FRANK C. PERKINS*

The accompanying illustration shows the construction of a novel English firebox designed and constructed at Gainsborough. It is claimed that the undoubted advantages of a locomotive boiler as a steam generator are sometimes offset by the troublesome necessity of frequently cleaning the boiler, especially when water of poor quality is used. One of the most difficult places in the locomotive boiler to clean effectually is the top of the firebox. The firebox is rectangular in shape and its four sides and top are usually reinforced by a



Small Locomotive Firebox with New Method of Bracing Top

number of stays. The top, having no adjacent sides to which to stay, is bridged over by several deep girders with suspending bolts supporting the flat plate. The girders make access for cleaning purposes difficult, and the bolts retard the mobility of the water and promote the deposit of scale. The result is not only a loss in heat transmission, but unequal heating is likely to occur, whereby the crown plate becomes unduly stressed in places and is liable to accident.

In order to obviate these drawbacks, Gainsborough English engineers have experimented for a long time with different forms of corrugated crown plates resulting in the firebox illustrated, which is held to be the strongest and safest crown plate of any of the various forms of corrugated tops which they tried. It will be seen that the corrugations spring from the opposite corners of the firebox, crossing diagonally in the middle, forming an exceptionally strong truss to the crown plate. These corrugations are obtained with the least possible stress in the material of the firebox, and their strength was proved by tests which were made, not only by hydraulic pressure up to 400 pounds per square inch, but also in actual steaming at a boiler pressure up to 180 pounds per square inch.

It is maintained that the shape of the corrugations enables them to steam freely, and the absence of cumbrous stays enables the top to be readily cleaned. The advantages possessed by this form include a slightly increased heating surface where the heating surface is of the most value, accessibility, and reserve of strength as well as economy in fuel, together with a decrease in weight of boiler. By abolishing the deep girders on the top of the firebox, it has been possible to simplify the staying of the end plates by dispensing with the heavy longitudinal stays and substituting stiffeners across the plates.

* * *

A man who minds his own business is a good man to have about, but the man who both *knows* and *minds* his business is better still.

*Address: Erie Co. Bank Bldg., Buffalo, N. Y.

WHEEL-TURNING OPERATION IN CLEVELAND CHUCKING MACHINE

The method of machining the sewing machine handwheel illustrated in Fig. 1, in a Cleveland chucking machine (built by the Cleveland Automatic Machine Co., Cleveland, Ohio) will be described in the following: This work is done in a machine of the chucking type, as the design of this handwheel, with its numerous arms connecting hub and rim, makes

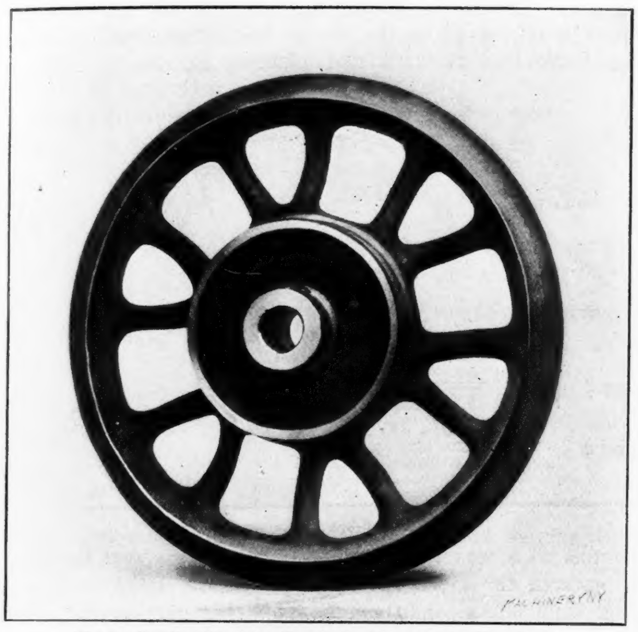


Fig. 1. Sewing Machine Handwheel Turned in Cleveland Chucking Machine

it impossible to use a magazine attachment. The mechanism on the turret end of the chucking machine is the same as that of the regular automatic type, but the spindle-head is somewhat different, in that it has a longitudinal adjustment to permit the use of large chucks for gripping castings of various shapes.

By referring to Figs. 2 and 3, which show the tool equipment for this particular job, it will be seen that a three-jawed chuck

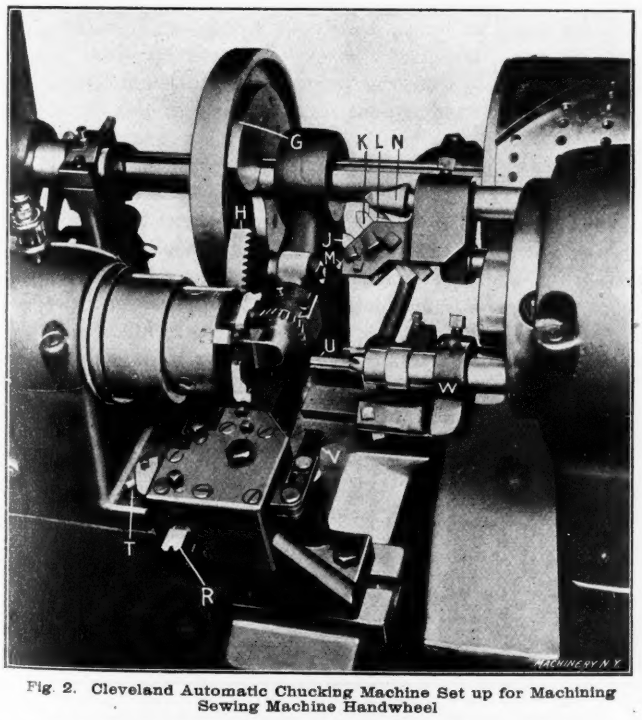


Fig. 2. Cleveland Automatic Chucking Machine Set up for Machining Sewing Machine Handwheel

is used, which has special jaws formed to fit the rim of the handwheel on the inside. The advantage of locating the wheel by the inside of the rim is that it will be in almost perfect balance after the outside has been machined. The chucking of the work can be done very quickly, it being possible to remove one wheel and place another in position in about five seconds. One man can take care of from six to eight machines, the output per machine being about sixteen finished wheels per hour, allowing time for grinding the tools.

In turning this wheel, the following operations are performed: Roughing and finishing cuts are taken over the rim by means of a special, circular turning attachment; diameter *B*, (Fig. 4) is rough turned to remove the scale, prior to finishing the belt groove with a forming tool; hub *C* has roughing and finishing cuts taken over the outside, and it is drilled, bored, reamed, and faced on both ends. The inner face *D* is finished by a special attachment which has a bar passing through the machine spindle, carrying at its end a flat facing cutter.

During the first operation, the tools *M*, *J*, *K*, *L*, *N*, and the special rim-turning attachment, are all in action. The rim-turning tool is actuated by cam *G* which imparts a reciprocating motion to segment gear *H* that is in mesh with a bevel gear as shown. This bevel gear is attached to a steel frame or tool-holder carrying the tool which turns the rim. This holder is mounted in large bearings at each end which are bolted to the top of the bed in front of the spindle-head. The rim-turning tool travels through an arc of a little more than 180 degrees. The functions of the various tools which are used during the first operation are as follows: The tool *J* rough

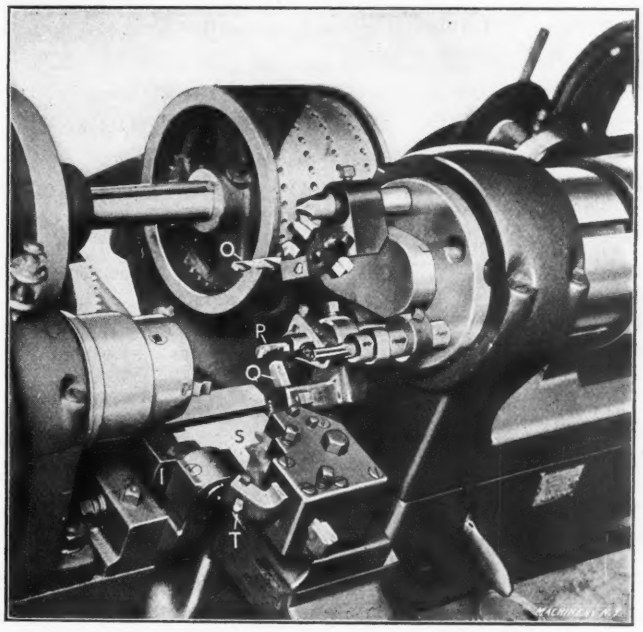


Fig. 3. Another View of Tool Equipment for Machining Handwheel

turns diameter *B*; *K* rough turns *C*; *L* faces hub *C*; *M* chamfers the sharp corner *E*; *N* spots the hub previous to drilling, and the tool in holder *I* turns the rim. During the second operation, a finishing cut is taken across the rim, and the hub of the wheel is drilled, the drilling and turning taking place simultaneously. To obtain the proper speed for drilling, drill *O* is driven by a high-speed drilling attachment which forms a part of the regular equipment. In the next operation, the hole in the hub is sized for reaming by boring-tool *P* which is held in an adjustable holder so that the tool can be properly located, regardless of changes due to grinding. Simultaneous with the boring operation, hub *D* is faced and hub *C* finish turned. In the fourth operation, the belt groove is finished by flat forming tool *R*, which also faces the outside of hub *C*, and turns diameter *B*. The hole through the hub is being finished at the same time by reamer *U*, and while this operation takes place, collar *W* comes into contact with lever *V*, swinging tool *T* into position for removing the sharp edge at *F*, which completes the operations. Tests on wheels finished by the method described showed that none was out of true more than 0.002 inch.

As one man can operate six of these machines, each of which has an output of sixteen wheels per hour, the cost of machining per hundred would be 37½ cents, or a little less than four mills each, a wage rate of $3.60 per day being assumed. This might be considered the maximum output under

favorable conditions, but if we assume that one man operates only three machines per day, which would be the minimum number under the most unfavorable conditions, the cost would be 75 cents per hundred, or a little less than eight mills per

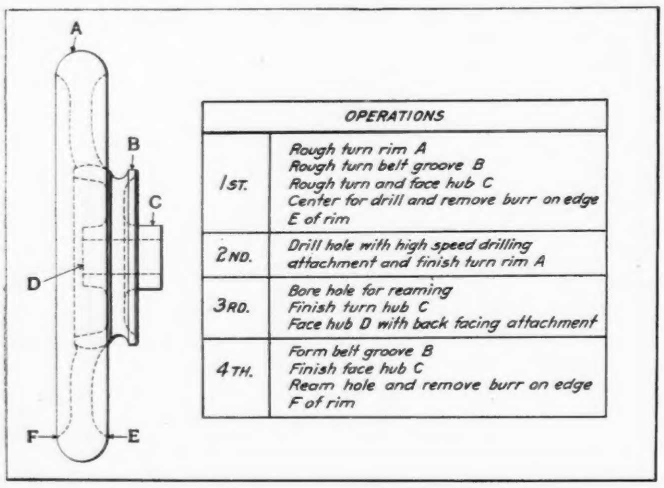


Fig. 4. Successive Operations on Sewing Machine Handwheel

wheel, the wage rate being the same as before. These figures will doubtless compare favorably with those obtained by any other method of doing this work, when the accuracy and excellence of the finish obtained is taken into consideration.

* * *

TROUBLES OF THE PATENT ATTORNEY

"In a town way down East," said Dobbins one day, "I used to know a patent attorney who was a mighty bright fellow and who came around the shop and helped us to frame up the claims for all our new schemes in such a way that when we read them afterward we did not know whether we were looking for a patent on a meat-grinder or a music-box. The claims were all right though, for we had one case taken to court on account of an infringement, and the lawyers wrangled over those claims for over two years; so sure enough, there must have been some substance to them. Well now, the reason why this particular patent attorney was so good and was able to put things through in the proper shape was because he was not only a patent attorney, but a mechanical engineer as well. If there was any fault to be found with him at all, it was that he was more of a mechanical engineer than he was a lawyer, and owing to that fact he was always unfortunate and lost his cases in court.

"I never saw him troubled over any mechanical contrivance but once. As soon as he saw the drawings he knew at once what we were driving at, and nearly always he had seen a similar device before. But one day Flannagin, over at our shop, got an idea of twisting a flat piece of stock so as to make a twist drill of it, something, by the way, that some one else did over in my father's shop forty years ago, but Flannagin twisted a shank to it, too, that would fit a Morse taper and he made a pretty slick job of it. Recognizing at once that here was an idea worthy of presenting before the wise men in the patent office down at Washington, he immediately called upon our friend the mechanical-engineer-patent-attorney, who gave due attention to the matter, framed up all the claims and made very nice looking drawings of the tool. To make sure before he sent them to Washington, however, he came over to Flannagin the other day and said, 'Say, Mr. Flannagin, about this twist drill, I would like to make sure that I understand it correctly. Now, which is the shank end and which is the drill end?' Well, Flannagin told him which was which and our friend said that was just what he thought, but he wanted to make sure!"

* * *

The total exports from the United States during 1910 represented a value of $1,864,491,644, and the total imports a value of $1,562,924,251. The volume of trade with the United Kingdom was greater than that with any other country. The exports to the United Kingdom amounted to nearly 30 per cent and the imports to about 18 per cent of the total exports and imports, respectively.

STREET CAR DESIGN

DRAW-BAR RADIATION AND MINIMUM WIDTH OF CAR BODIES

By WARREN M. SMITH*

The formulas given in this article have been developed by the writer to facilitate certain features of street car design, and have been successfully used for that purpose.

Draw-bar Radiation

Draw-bar radiation is the angle at which the draw bar stands with regard to the center line of the car, when the

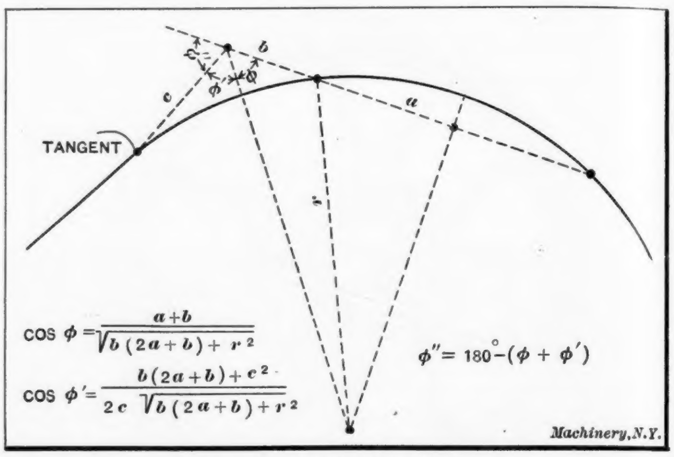


Fig. 1. Draw-bar Radiation Diagram

latter is on a curve. It frequently so happens that this angle is required for given radius of curvature, truck centers or other influencing conditions, and for that purpose the accompanying formula was developed. It will no doubt be found useful, especially on street railway and interurban work.

Except in the case of a reverse curve, when one truck is on each curve, the maximum degree of radiation will occur when the forward car is wholly on the curve and the draw-bar pin of the rear car is just striking the tangent. The angle in-

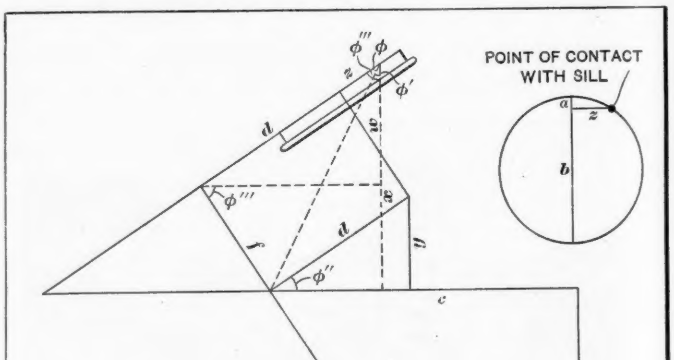


Fig. 2. Car Body and Truck Diagram to determine Minimum Car Width, Truck Radiation, and Bolster Centers for Given Curves and Wheel Sizes

creases up to this point, but beyond, it decreases. These conditions may be readily seen by reference to Fig. 1.

While as before mentioned, the radiation is greater on a reverse curve, experience has proved that it is unnecessary to provide for the excess swing thus given, as it has been found in practice that the ordinary service curve on a line of

* Chief Draftsman, J. G. Brill Co., Philadelphia, Pa.

railway is of such a character that if sufficient clearance were allowed for the radiation of the draw bar on the curve, two cars could very readily pass over any reverse curve on the line. It is the general practice to provide for sufficient radiation of the draw bar on the ordinary railway curve.

In Fig. 1:

a = half the distance between bolster centers;
b = bolster center to draw-bar pivot;
c = total length of two draw bars;
r = radius of curvature of the line;
ϕ'' = angle of radiation.

The lower end of the draw bar is shown just striking the tangent to the curve.

From an inspection of Fig. 1, it may be seen that

$$\cos\phi = \frac{a+b}{\sqrt{(a+b)^2+(r^2-a^2)}} = \frac{a+b}{\sqrt{b\,(2\,a+b)+r^2}}$$

Also from the trigonometric equation of the two sides and the contained angle

$$\cos\phi' = \frac{c^2+\overline{(a+b)^2+(r^2-a^2)}-r^2}{2\,c\sqrt{(a+b)^2+(r^2-a^2)}} = \frac{b\,(2\,a+b)+c^2}{2\,c\sqrt{b\,(2\,a+b)+r^2}}$$

From these equations, ϕ and ϕ' are found, and thereby ϕ'', the desired angle, is obtained, for

$$\phi'' = 180^\circ - (\phi+\phi')$$

This may be readily worked out as the two angles ϕ and ϕ' are in the three known terms a, b and r.

This formula cannot be used in connection with a curve of any other character than that ordinarily used in cities, or a curve that is of one radius from tangent to tangent; nor is it applicable to a curve unless it is a true arc of a circle.

Minimum Width of Car Bodies for Given Curves and Wheel Sizes

The general design of a car body, and therefore of the distance between the car sills, is influenced by the fact that the wheels have a tendency to strike the sills when taking a curve. This factor is dependent upon the amount of truck radiation, bolster centers, wheel-base, size of wheel, and radius of curve; all these influencing factors are interdependent. Fig. 2 diagrammatically represents these conditions.

In this figure

a = top of wheel tread to the bottom of the sill, for a loaded car;
b = top of track to bottom of sill for a loaded car;
c = half the distance between bolster centers;
d = half the length of wheel-base;
f = center of truck to the outside of the tread;
r = radius of curve;
x = center of car to point of contact on wheel, *i. e.*, half the distance apart of car sills;
y = center of car to center of axle.

From similar triangles

$$a:z::z:b$$

therefore

$$z = \sqrt{a\,b}$$

Also

$$\cos\phi''' = \frac{c}{r}$$

hence

$$w = (d+z)\cos\phi''' = (d+\sqrt{a\,b})\cos\phi'''$$

As

$$v = \sqrt{r^2-c^2}$$

and

$$v : r :: x-w : f$$

then

$$r\,(x-w) = v\,f$$

or

$$x-w = \frac{v\,f}{r} = \frac{f\sqrt{r^2-c^2}}{r}$$

therefore

$$x = (d+z)\cos\phi''' + (x-w) = \frac{c}{r}(d+\sqrt{a\,b}) + \frac{f\sqrt{r^2-c^2}}{r}$$

$$= \frac{c\,(d+\sqrt{a\,b})}{r} + \frac{f\sqrt{r^2-c^2}}{r}$$

or

$$x = \frac{c\,(d+\sqrt{a\,b})+f\sqrt{r^2-c^2}}{r} \qquad (1)$$

Also

$$\tan\phi = \frac{f}{d+\sqrt{a\,b}}$$

and

$$\cos\phi' = \frac{x}{\sqrt{(d+\sqrt{a\,b})^2+f^2}}$$

and

$$\phi'' = 90^\circ - (\phi+\phi') \qquad (2)$$

hence

$$c = r\sin\phi'' \qquad (3)$$

Formula (1) determines the minimum width that a car body may be built, so that the trucks will not strike; formula (2), the greatest allowable truck radiation; and formula (3), the maximum bolster centers of the two trucks, and at the same time provides sufficient clearance for the truck when the width of the car is established.

These formulas may be used to determine the various measurements of the car body and its trucks for any of the eight variable factors previously tabulated.

* * *

SIMPLE CLAMPING DEVICE

The illustration Fig. 1 shows a fixture that was furnished with the engraving machine built by the Geo. Gorton Machine Co., Racine, Wis., for holding a certain long piece on

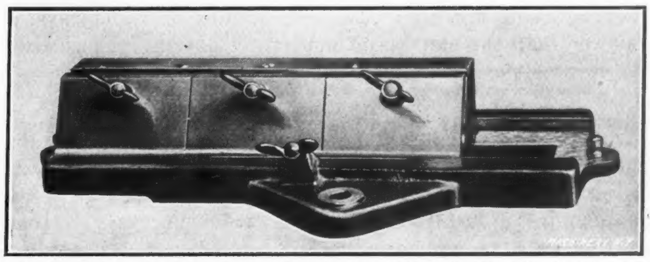


Fig. 1. Fixture used on Gorton Engraving Machine having Simple Clamps

which a line of letters is engraved. It was necessary to provide a clamp for holding the sliding block to the base.

Fig. 2 shows how Mr. Charles Rothweiler, the superintendent, made the clamp. The simplicity and ingenuity of the construction will be apparent with but little explanation.

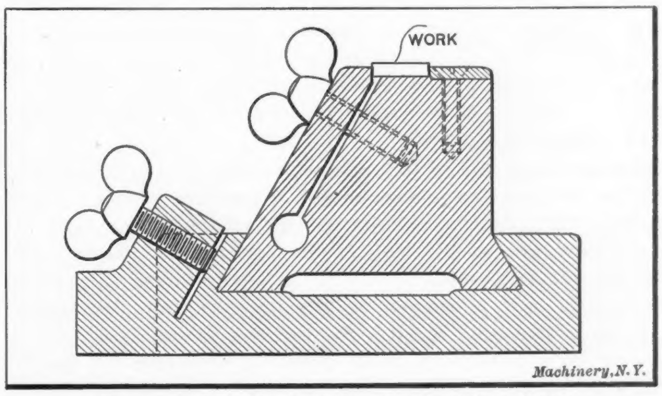


Fig. 2. Cross-section of Fixture showing Clamp Strip

A saw cut was made in the base about three inches long, shown in Fig. 1, back of the lower thumb-screw, at the same angle sideways as the side of the dovetail groove in the base. (See the cross-section Fig. 2.) The thread for the thumb-screw is tapped in the lug, and the end of the screw abuts against the thin strip of metal between the saw cut and the slide. A slight twist of the screw suffices to deflect the clamp strip and firmly clamp the closely fitted block.

ELECTRIC BLUEPRINTING

By H. W. WEISGERBER*

The essential thing in electric blueprinting is the paper. Sun paper cannot be used profitably for electric printing, so a special "extra rapid electric paper" is made for the use of artificial light. A paper that will print in about thirty seconds in bright summer sunlight, and which has good keeping qualities, will prove satisfactory.

Fresh paper prints more slowly than old, but washes more quickly; this means that the old paper prints more rapidly, but must be left in the bath for a longer period. The fresher the paper, the whiter the lines, while lines on old paper have a dull or grayish cast. In trying out new samples of paper, use small pieces along with one from the roll with which comparison is to be made, and place all of them over one tracing.

In damp weather the paper will wrinkle and cause poor contact, but this defect may be overcome by allowing the paper to expand before being placed over the tracing in the printing frame. This wrinkling is less troublesome in winter when artificial heat is used, than it is in summer. Paper as it comes off the roll is very dry, readily absorbing the moisture of the air, and must be given time to swell evenly, or a hit and miss contact will result.

Printing

To do good work the lamp must be hot, for in a cold lamp the carbons and rheostat offer too much resistance; consequently, the lamp must heat for several minutes before printing begins. After being in use for ten or more minutes, it has warmed up to normal, and the time of exposure can be shortened by increasing the speed. Overexposing is always preferable to underexposing, for the former can be remedied in the bath; yet the speeding of the lamp, as above suggested, should not be carried too far. It takes time to make blueprints, even in bright summer sunshine, and though the photo-engraving arc light is rich in actinic, or violet rays, it is slower than the sun, so do not expect a print in less time than is possible by sunlight.

The Lamp

Arc lamps are not infallible and should be no less carefully tended than any other machine, if satisfactory results are desired. A lamp that draws current from the same line as the shop motors probably suffers more from fluctuations than one that gets its current from a steadily loaded generator. The greatest annoyance is that due to "flicker" or "flaming arc." This can often be overcome by throwing the switch, and generally ceases as soon as the lamp becomes hot. The "creeping up" of the arc on the upper carbon is often caused by too long an arc, *i. e.*, the carbons are too far apart. An inch and a quarter arc made possible by adjusting the dash-pot-rod will give good results. A weak current, one below that for which the lamp is made, will also cause a short arc. Frequently a connection working loose will cause a loss of current and also make a short arc. If a lamp does good work, barring a little irregularity, it is advisable to leave well enough alone.

The printing rays of light emanate from the "point" of light on the hottest spot on the upper or positive carbon; consequently the printing rays extend downward rather than upward, and are on the side of the carbon that displays the "spot." If the carbon burns to a longer taper, the carbon point will cast a shadow on the opposite side and lighter colored prints will result. Neither the aureole nor the reflected rays have very great printing properties; it is the band of violet rays that does the work. A newly trimmed lamp must be allowed to burn clear before the machine is started, as it initially burns "yellow"—a color that will not print.

The lamp globes should fit snugly. At the same time they should not be so tight as to interfere with the expansion of the glass nor with the escape of the gases when the current is turned on. They should be handled carefully, for a chip out of the edge soon means a broken globe. A little milkiness (the white dust-like coating in the globe) is beneficial, for it diffuses the light and makes a better printing medium than clear glass.

Washing the Prints

Many prints are spoiled in washing from insufficient soaking. The blue background must be "fixed," and this takes time; prints that are soaked from two to five minutes will remain blue longer without fading than those that are simply put in the bath and taken out. All prints fade somewhat when placed in direct sunlight, but the poorly washed ones turn white. There is no cure for an underexposed print, but an overexposed one, if not "cooked," can be developed with potash solution.

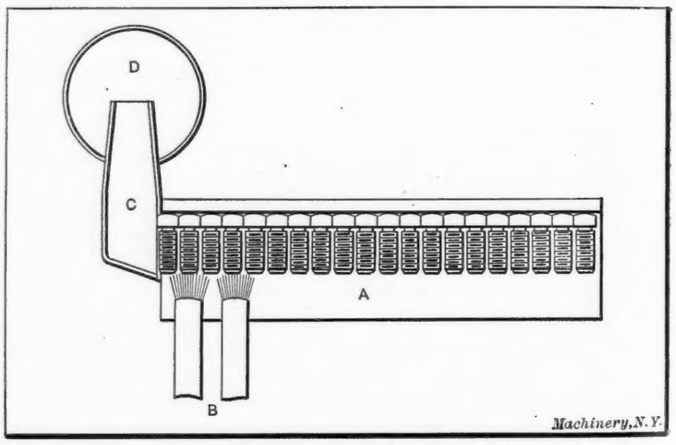
For the developer, use one-half ounce saturated solution bichromate of potash to each gallon of water in the bath. To use the potash economically, the bath water need not be changed every day, for by adding about two ounces of formaldehyde to a barrel of water as a deodorant, the water in the bath may be used for a week or two, even in "dog days," without any odor arising. This germicide also destroys all sliminess in the pan, and even at full strength it does not injure the prints. It is, however, a powerful astringent, and if too much is used it will be harsh on the hands. Wet prints should never be hung in the light near a window, for they fade more quickly when wet than when dry.

*Address: 321 Franklin Ave., Salem, O.

* * *

HARDENING SET-SCREWS

The illustration shows the plan of a simple outfit for hardening the points of set-screws used in the well-known Armstrong tool-holders made by Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago. The screws are laid on an inclined plate *A* with the heads against a ledge that keeps them from sliding off. Two Bunsen gas burners *B* are set so that the flames are directed against the points of four or five screws



Semi-automatic Set-screw Hardening Outfit

on the left end. At the same end of the plate is a chute *C* directed into a tub *D* containing the cooling bath.

The hardener places the screws on the plate *A*, beginning at the right and putting another screw on the moment the screw at the extreme left has reached the hardening heat. The action of putting on another screw punches off the heated screw into the chute from which it descends into the bath. The hardening process is thus semi-automatic; the hardener simply picks up the screws and puts them on the plate as fast as the screws in front of the burners become heated, and no other handling is required.

The method is highly efficient, the percentage of hard points being nearly 100, as is shown by the file test to which every set-screw is subjected. It is rapid, too, since four or five screws are heating at once, but as the heating is progressive, there is no confusion, and practically every screw is quenched at the right moment.

* * *

Extract from letter: "I wish someone would invent a plan whereby draftsmen could exchange places, get fresh ideas, and see new methods, and, incidentally, get some fresh air." Not such a bad idea, either! Suggestions are invited.

ADJUSTING STRIPS OR GIBS USED ON MACHINE TOOLS

By JOSEPH G. HORNER*

"Adjusting," "take-up," or "gib" strips, as they are variously termed, are used so extensively that it is but natural to find a great number of varieties, differing in form and manner of application. Different conditions are imposed by the sizes of the machines on which they are used, by the mass of certain sliding parts, and by the particular functions which they have to perform. The shapes of the slides have a modifying effect upon the strips, and the nature and direction of the strains

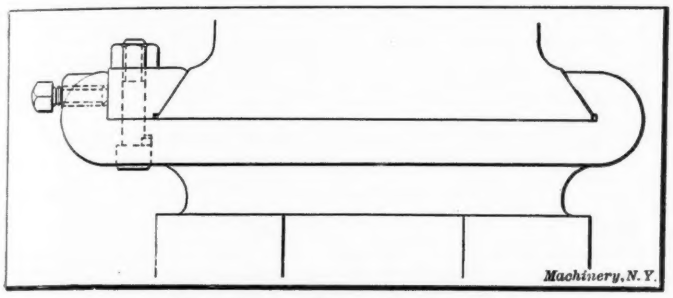
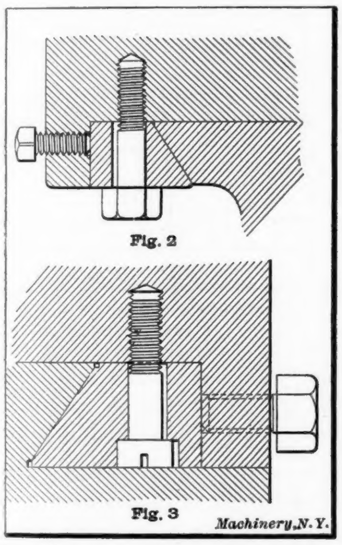


Fig. 1. Common Form of V-strip or Gib

on the slide must be taken into consideration. In addition to these questions, the matter of space or clearance often determines what class of strip shall be employed. In some kinds of slides there is complete freedom for the projection of adjusting screws, while in others the arrangements are necessarily so cramped and confined that various modifica-



Figs. 2 and 3. Modified Arrangements of V-strips and Adjusting Screws

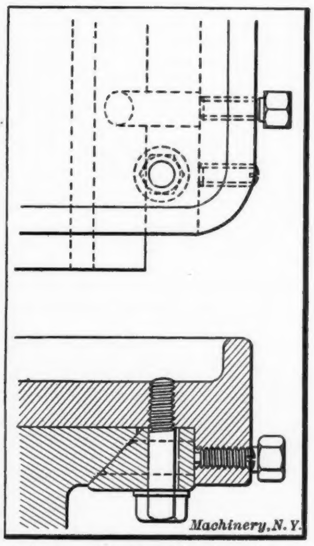
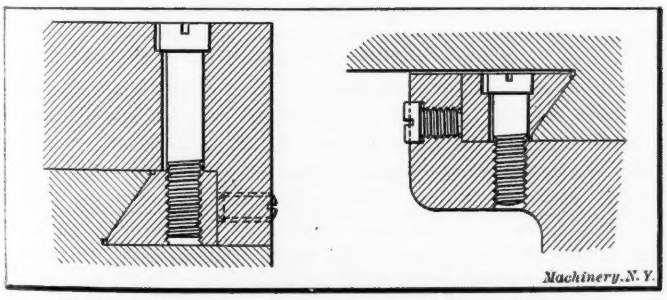


Fig. 4. V-strips with Clamping Plugs or Shoes

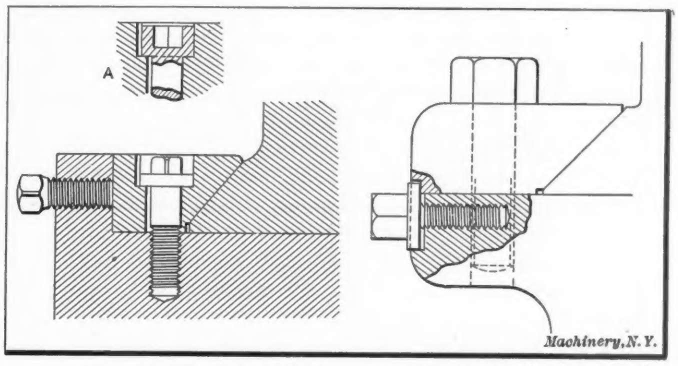
tions have to be made in order to accommodate the adjusting screws and to make them easily accessible. Cases are sometimes met with in which the adjusting screws of a gib or strip are most awkwardly located, when—by a little thought—another arrangement could have been adopted. Sometimes the substitution of a different kind of screw will make all the



Figs. 5 and 6. Strips with Different Types of Adjusting Screws

difference between facility of manipulation and extreme difficulty.

The problem of locking a slide is sometimes solved by fitting a lateral screw or screws to press upon the adjusting strip, but there are also several other methods. Usually the provision for locking does not affect the strip in any way, but there are instances in which a slideway is so weak and flimsy that the tightening of the locking screw or screws will spring the metal of the slideway inward, and so cause it to

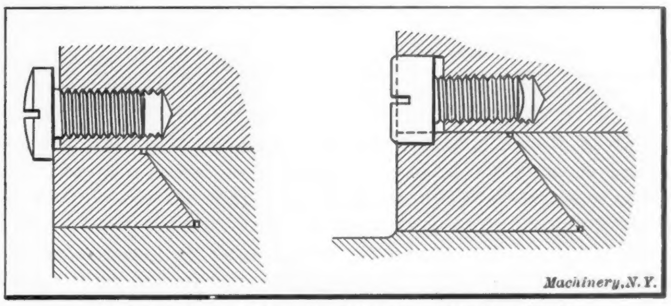


Figs. 7 and 8. Strips with Countersunk Square Heads and Collar-head Adjusting Screws

recede from the gib of the slide itself, thus producing slackness, and partially defeating the object of the locking.

Main Types of Gibs or Strips

Practically all adjusting strips belong either to the V-type or to the square-edged type, and all modifications are based upon these two classes. These types are further sub-divided



Figs. 9 and 10. Strips adjusted by Round Screw Heads

into three main groups, according to the mode of "setting-up" or adjusting:

1. Strips forced laterally by screws acting at right angles to the axis of the slide.
2. Angular strips pulled or forced sideways so as to have a wedge action between the slide and the slideway.
3. Strips tapered longitudinally and forced in that direction, thus having a wedge action.

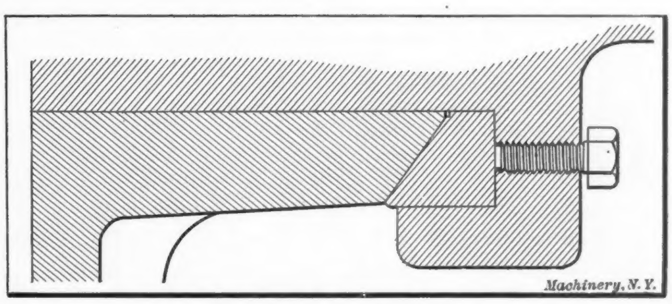


Fig. 11. Strip for Planer Bed

There is ground for believing that the last-named type will in the near future greatly supplant, if not oust, the first-named style of strip, and possibly also the second kind. The simplicity of the wedge adjusted endwise is obvious, and it is being employed more and more in new constructions, both on large and small slides.

The function of a take-up strip is to prevent slackness between the slide and its slideway, and to compensate for wear. While a strip may prevent lateral shake of a slide, it may or may not prevent the lifting which is likely to occur when the pressure of the cut tends to separate the slide from its way. In this case it will be necessary to employ another strip, if the arrangement of the adjusting strip does not provide for resisting the strain in both directions. On the other hand, many instances occur in which only one strip, or a pair of

* Address: 45 Sydney Buildings, Bath, England.

strips, is necessary to check the lifting tendency, and the shape of the slideways provides against lateral displacement. A lathe bed with V-ways affords such an instance; but in the case of square-edged slideways, the single lateral strip is insufficient, and it must be supplemented by a gib underneath,

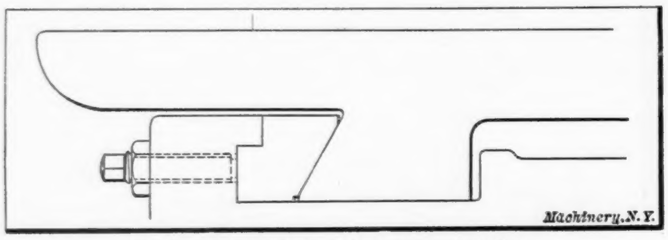


Fig. 12. Strip with Shoulder to prevent Lifting

or the latter must be combined with the former, and a right-angled strip used. The choice of either method is often a matter of convenience; in certain cases the combined form of strip is impracticable, on account of space restrictions or other requirements. Another condition is met with in the slides of certain grinding machines, which have one V and one flat

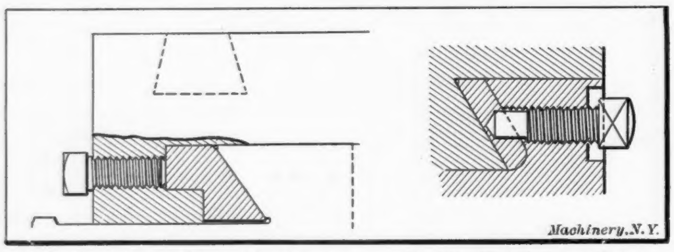


Fig. 13. Strip with Shoulder to prevent Downward Movement

Fig. 14. Flat Strip used on Dovetail Slide

way, and which do not require any form of gib for the prevention of either lateral or vertical movement. Again, when the heavy table of, for example, a planer runs upon two flat ways, it is only necessary to provide lateral strips; but if the machine is a light one, lifting must be guarded against either by fitting top gib strips to press downward, or by adopting another kind of slideway, such as an inverted V or dove-

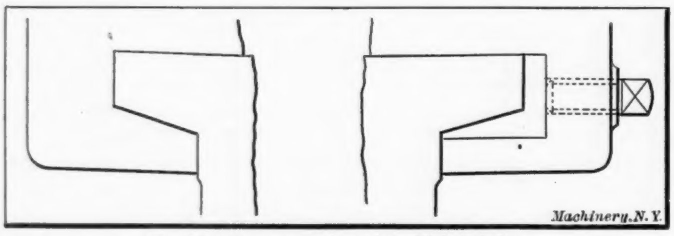
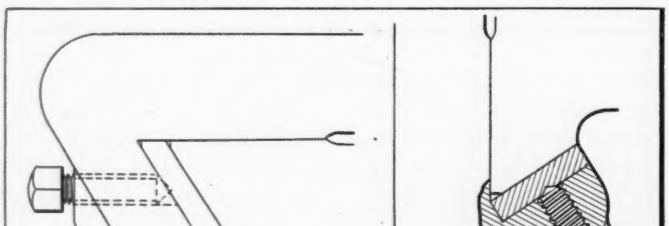


Fig. 15. Arrangement used on Link Grinder

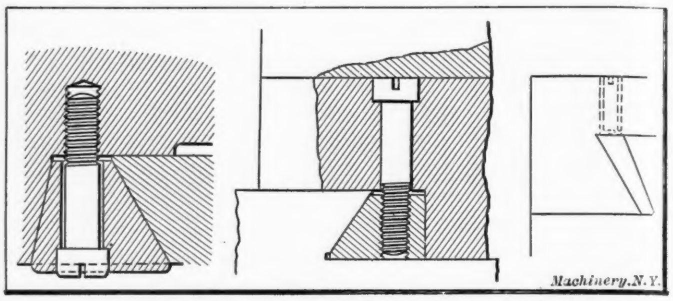
tail, or by putting gib strips underneath the ledge of the bed ways.

It is now proposed to briefly review various kinds of take-up strips, the examples shown in this article being taken from a wide range of machine tools made in different countries. Perhaps the most common type of strip is that shown in Fig. 2, which is used to a very great extent, either as illustrated,



Figs. 16 and 17. Different Methods of Applying Adjusting Screws to Flat Gibs

or with numerous slight modifications. It provides for lateral adjustment and for vertical take-up, and may be found on nearly all classes of lathes and machine tools. The other edge of the slideway is usually of V-shape, but sometimes it is cut to a square shape, in which case a flat strip at the bottom is required to prevent lifting at that edge. The precise arrangement of the adjusting screws depends upon the circumstances; sometimes bolts, see Fig. 1, are better suited for taking the weight of an overhanging knee (a milling machine in this case). Provision for locking the slide to the pillar is here made by fitting handles on two of the bolts, instead of nuts, so that the strip may be forced hard against the V-edge. Another means of clamping which does not utilize the strip, is that represented in Fig. 4. Here a circular plug or shoe passes through the strip and is pressed against the edge of



Figs. 18, 19 and 20. Different Types of Wedge Gibs

the slideway by a hexagon-head set-screw, the strip being adjusted by headless screws. The possible objection to this device—that the action of the screw has a tendency to force the table apart from its slide—does not apply to the arrangement in Fig. 1, where there is a truer clamping action.

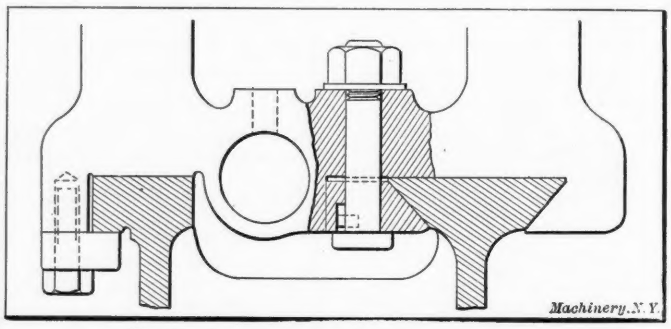


Fig. 21. Arrangement used for Gear-cutter Head

Modified arrangements of the adjusting screws are seen in Figs. 3 to 8. In Figs. 3, 5, and 6 are shown examples where the strip is closed in by the slide construction, so that while the adjusting or setting-in screws are not necessarily affected,

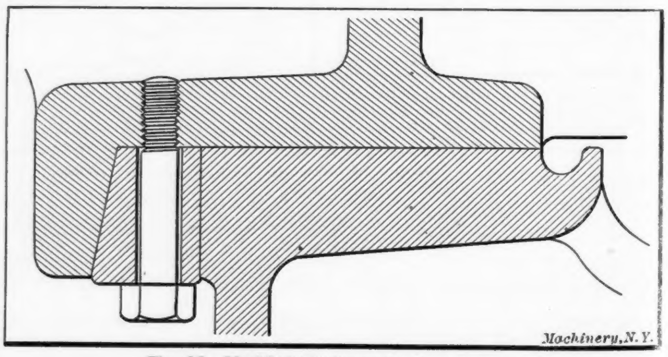
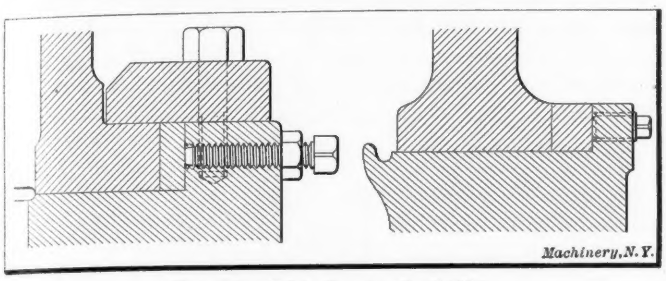


Fig. 22. Modified Wedge-strip Arrangement

the pulling-up screws are modified in various ways. In Fig 3—showing the gib for a slide-rest—the pulling-up screw passes through the strip up into the top slide, while in Fig. 5 the arrangement is reversed, the latter design making the screw easier of access. The milling-machine slide gib shown in Fig. 6 has a screw sunk flush with the face of the strip to permit of the passage of the table. Other slight differences are made in regard to such arrangements, but it is unnecessary to illustrate all of these. An alternative to the use of a slotted screw-head is seen in Fig. 7; the head has a collar and a square for manipulation with a wrench, a method that is better suited for heavy strips than the use of a screw-driver; the head may also be of the hollow type, with a square inside, as shown in the detail at *A*, Fig. 7. In Fig. 8 is seen a modi-

fied form of adjusting screw, used when there is no metal outside the strip for the insertion of a screw, this example being taken from a shaper saddle. The set-screw has a large collar which presses against the back of the strip and forces it inward.

Another distinct class of strips is characterized by the absence of the pull-down screws shown in the examples hitherto



Figs. 23 and 24. Square-edged Gibs

illustrated. The friction of the setting-in screws is relied upon to prevent backward motion of the strip, and while this cannot always be depended on if the slide is subjected to much strain or to excessive vibration, it answers sufficiently well for many purposes, being frequently employed for the slides of small lathes and other machines. Fig. 9 is an instance of this, although the arrangement used in this case is not very workmanlike; that shown in Fig. 10 is to be preferred, both on the score of neatness and of durability, because the head is protected, and the close fit of the head in the counterbore helps to prevent the screw threads from loosening. The ex-

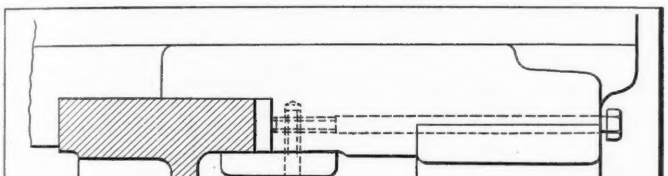


Fig. 25. Arrangement Requiring Abnormally Long Adjusting Screws

ample in Fig. 11 is taken from a small planer, and shows a V-strip set up against the inner edge of one bed-way, the other inner edge fitting as solid metal to metal to the table. The lip carried underneath the strip obviates the need for a second screw. A projecting lip on the strip is another means for checking its tendency to lift. An example of this is shown in Fig. 12; the shoulder keeps the strip in place, as is also the case in Fig. 13, although the strip is reversed in the latter case. A slight clearance under the bottom of the strip prevents it from being jammed onto the lower slide and binding this to the upper slide.

Fig. 15 is a strip for a link grinder, where the table saddle embraces the bed on one side, and a gib of corresponding form is adjusted by a row of screws on the other. A popular style of strip is that shown in Fig. 14; it differs from the examples previously shown in that it is of flat shape, although it is pressed against a V-edge. It is often used for light slides. A gib of similar design is fitted to a different kind of slide in Fig. 16; and in Fig. 17 the setting-up screws are located at right angles to the face of the strip.

After having reviewed these examples of gibs or strips fitted with setting-in screws but without pull-down screws, some of the opposite type, *i. e.*, those provided with pull-down screws only, will be shown. This method involves the utilization of wedge action, advantageous both from the point of view of simplicity, and because of giving solid metal-to-metal pressure, independent of any setting-up screws. Fig. 18 is a gib of this kind, while the gib in Fig. 19, an example taken from a slide-rest, acts similarly, but has its back cut perpendicular instead of beveled. The gear-cutter head, Fig. 21, is gibbed in a similar way, but with a bolt to pull up the strip. As the head is guided only by one slideway, there is clearance on the other way, and a flat gib only is required to prevent lifting. In slides where the strip is too thin to permit of the passage of a screw, the alternative shown in Fig. 20 is adopted, a row of screws forcing the strip down. As a last example of this character, Fig. 22 may be noted; although a wedge strip is utilized, the edge of the slide is square, as the lifting tendency is prevented by the weight of the table—that of a

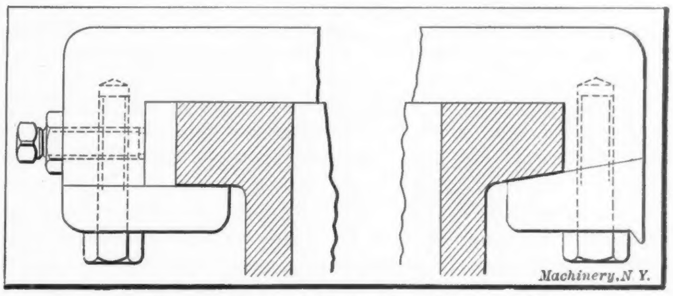
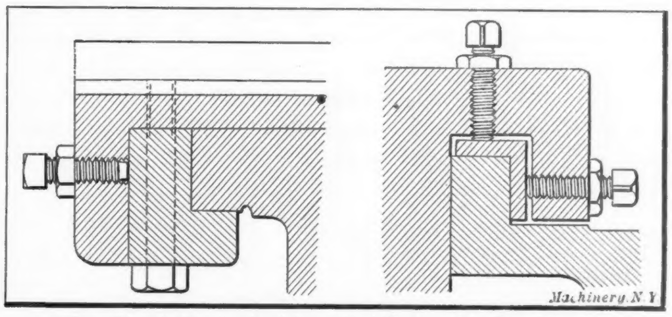


Fig. 27. Two Types of Gibs used on Grinder Saddle

planer. The strip is placed on the outside of the way, the outer edge of the companion way fitting against the solid shoulder of the table.

Square-edged Gibs

Some attention will now be given to square-edged gibs, of which various kinds are shown in the engravings Figs. 23 to 30. As with V-strips, the side-setting screw is commonly employed, as shown in Fig. 23 (an example taken from a shaper ram), and if lifting has to be prevented, the usual gib or plate, pressing downward, must be included. If no lifting



Figs. 28 and 29. Angle-strips with Adjustment in Two Directions

is to be feared, the plain strip, Fig. 24, is sufficient. This example is taken from a planer with two flat slides, the strip and screws being placed on the inner side of the left-hand way, while the other way has a solid shoulder. Fig. 25 is rather an unusual case of a lathe carriage in which the adjusting screws have been made of abnormal length in order to bring their heads to the front, the only location where access to them is possible. The front shear of the bed forms a narrow guiding way, and only a flat gib is required on the other shear to catch under the lip of the ledge. A strip and gib for a turret-lathe slide is illustrated in Fig. 26; it will be seen that the strip is prevented from moving endwise by two locating pins, and that the top surface of the saddle is recessed to facilitate scraping down, to lower the gib.

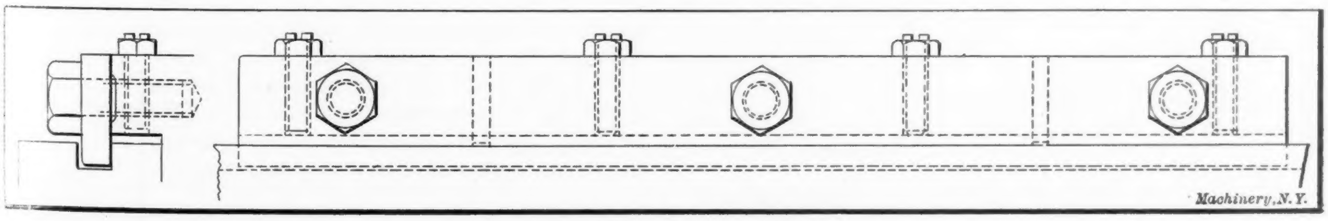


Fig. 26. Arrangement used for Turret Slide

Fig. 27 shows a design which combines a square strip and gib plate on one side of a bed, and a solid square-edge, fitting

with a gib of moderate bevel, on the other. This construction is used on a piston-rod grinder saddle, and the beveled strip has a lip extending along its bottom edge to let the lubricant drop straight down into a trough below. The combination strip illustrated in Fig. 28 is often used in preference to separate strips, it being adjustable in two directions; when set

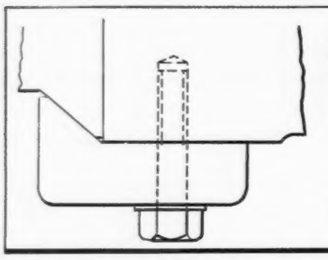


Fig. 30. Gib for Shaper Saddle

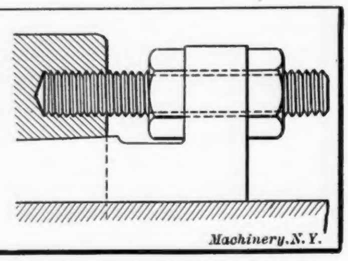


Fig. 31. Usual Method of Adjusting Taper Gibs

up vertically, it is of course necessary to scrape down the surface of the strip until it makes contact with the lower bearing surface of the bed. Another class of strip that can be adjusted in both directions, is shown in Fig. 29; it requires no scraping, and is used on the top portion of a side-planer tool-box, the other part of the slide fitting a V-shaped way. The arrangement is sometimes changed about, with the V

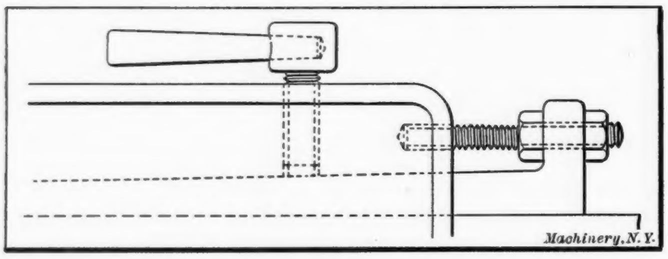
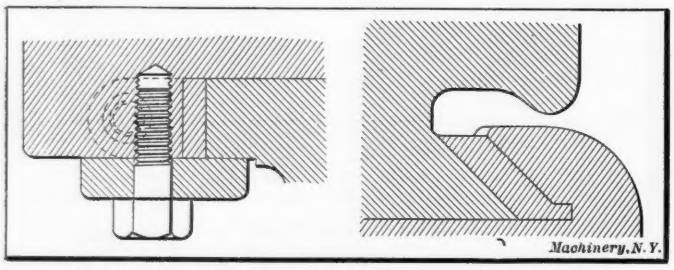


Fig. 32. Taper Gib with Clamping Arrangement

above and a square-edge below. A different form of V is also often employed, with a strip like that shown in Fig. 30, this being commonly applied to shaper saddles, with various slight modifications of style.

Taper Gibs or Strips

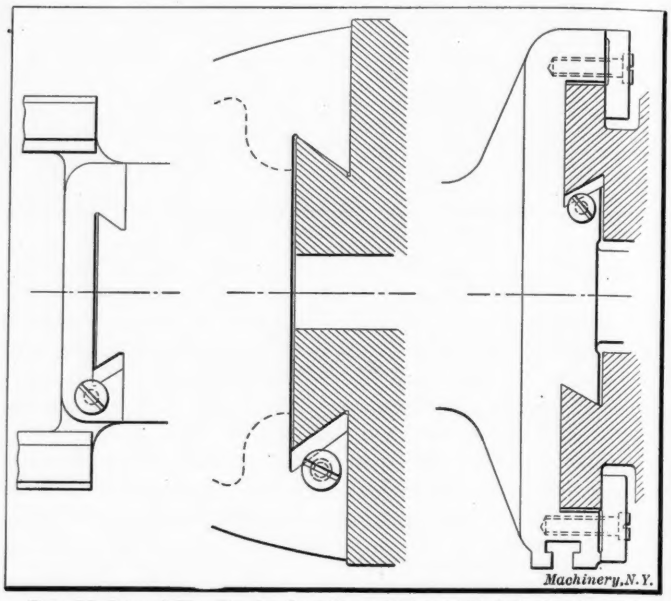
Finally we come to the gib which is tapered longitudinally and which has no side-setting screws. This, as previously



Figs. 33 and 34. Different Methods for Preventing Taper Gibs from Lifting out of Place

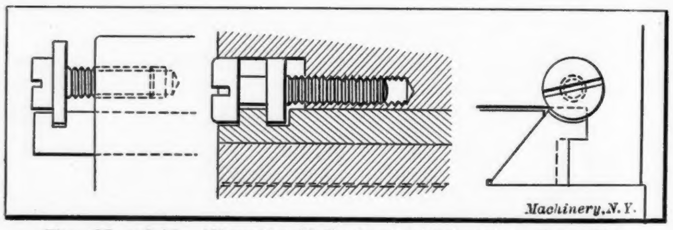
mentioned, seems destined to largely supersede other types of gibs, particularly for certain classes of slides. It is simple, the number of adjusting screws is reduced to one, the pressure along the side of a slide does not depend upon the variable pressure of a row of screws, and it binds against a solid mass of metal between the fixed and the moving parts, so that no springing action can occur except by the spreading or opening out of the metal in the saddle, or the closing in of that in the slideway. Its simplicity alone, however, has perhaps secured for it more adherents than any of its other advantages. There are many places where it is easier and simpler to accommodate the one adjusting screw of the taper gib at the end than to find space and means of access for the row of side-setting screws of the ordinary strip; and it leaves the designer with a freer hand to carry out ideas which would have to be more or less modified and restricted by the fact of a side-setting strip being fitted.

Fig. 31 shows the usual method of moving these strips, a stud being screwed into the slide, saddle or carriage, and,



Figs. 35, 36 and 37. Varying Locations of Taper Gib Adjusting Screws

passing through a hole in the head of the strip, allows the latter to be adjusted in either direction, and locked by the two nuts. The screw itself does not turn in this case, but as we shall see later, circumstances may require the employment of a different kind of screw. The clamping of a slide is sometimes effected by screw pressure, the screw acting on the



Figs. 38 and 39. Alternative Methods of Adjustment for Taper Gibs

strip, as seen in Fig. 32, or it may be done in other ways, independently of the strip.

When a taper strip is fitted to a square-edged slide, the lifting of the slide must be prevented either by means of an ordinary gib plate, as in Fig. 33, or by carrying the lip of the slide down underneath, and fitting another taper strip which will thus lie at right angles to the first. This is employed, for example, on the saddles of some planers, where the saddle fits the square-edged top portion of the cross-rail.

In the smaller strips, and where space is limited, the adjustment is more suitably made by ordinary fillister-head screws, pressing either on the ends, or being sunk in a short distance, to avoid undue projection. A screw at each end of the strip provides for movement in both directions, and checks the tendency to jam. The precise location of the screws in relation to the end of the strip is usually a matter of judgment, depending on the most convenient location. Figs. 35,

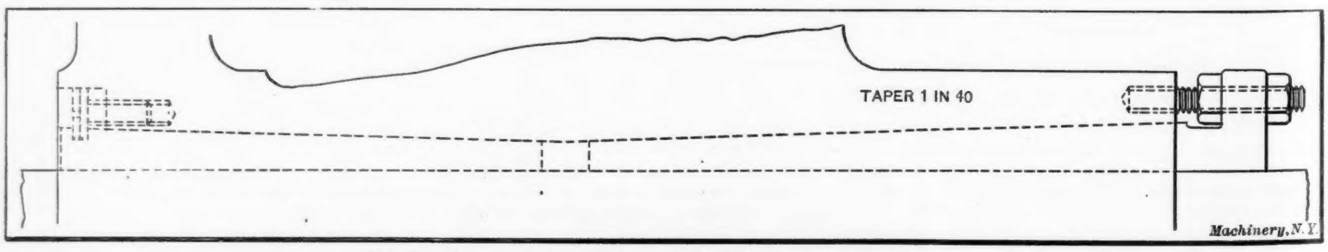


Fig. 40. Arrangement of Gibs on a Multiple-spindle Drilling Machine

36 and 37 show three common arrangements. In Fig. 35 the location of the adjusting screw is at the corner of the strip, in Figs. 36 and 37 it is placed at the side, and in many instances it is located at the bottom. Figs. 35 and 36 are complete without extra gibs, but in Fig. 37 a pair of strips bearing on the under ledges of the square lips is provided. These two latter examples are of milling-machine spindle heads.

Fig. 34 shows a modification sometimes made in taper strips, where there is nothing to prevent the strips from lifting. A small tongue is formed on the strip, and fits into a groove in the slideway (in this case the saddle of a milling machine). The tongue could only be dispensed with if the under face of the table came down flush with the top of the slideway.

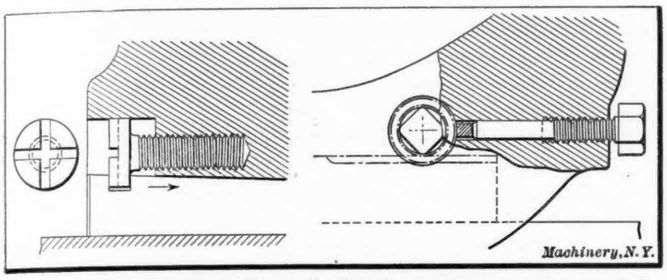


Fig. 41. Detailed View of the Adjusting Arrangement shown to the Left in Fig. 40. Fig. 42. An Unusual Arrangement: Taper Strip Adjusted by Rack and Pinion

A few different ways of adjusting taper strips are shown in Figs. 38 to 42. The collar-head screw, engaging in a notch in the strip, Fig. 38, is very common; it provides for adjustment in both directions, and does not take up so much space as the stud with its two nuts in Fig. 31. Another method which is still more compact is that shown in Fig. 39, where a double collar screw is used, sunk nearly flush with the face of the slide. The strip, as will be noticed, is shouldered to prevent its jamming down onto the slideway.

A rather peculiar combination is shown in Fig. 40, this being the gibbing arrangement of a saddle for a multiple drilling machine. On the right-hand or outer side there is no restriction, so that a strip with head and the usual stud and nuts is permissible; but on the left-hand side a different arrangement is necessary, because that side has to meet the corresponding face of a companion saddle so as to bring the drill spindles together as close as possible. The strip on this side is, therefore, fitted with a countersunk screw of the large-headed type; as shown in the detail, Fig. 41, the screw has two slots at right angles—otherwise the screw-driver could not be applied.

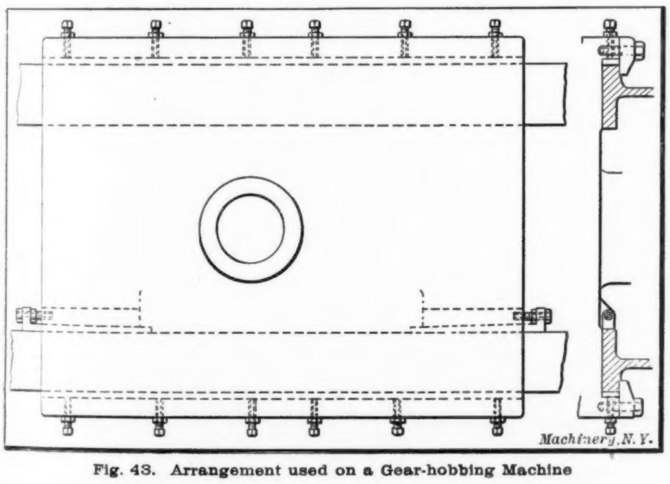


Fig. 43. Arrangement used on a Gear-hobbing Machine

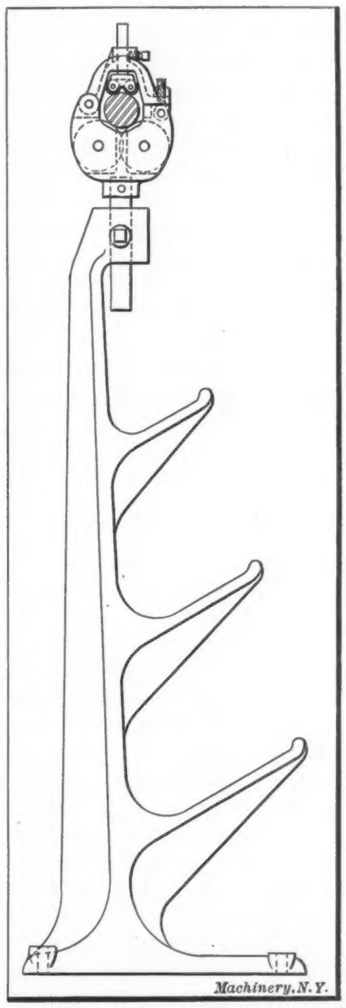
Another method of adjusting a strip is shown in Fig. 42, in which, owing to the construction, no other method is conveniently applicable. The strip has a few rack-teeth cut upon its end, and these engage with a pinion on the end of a spindle which comes to the front of the saddle (that of a radial drilling machine), and is turned by a wrench. After adjustment, the spindle is secured by clamping it with the set-screw and "shoe" at the side. An alternative method, occasionally employed, is to provide the strip with a couple of pins standing out at right angles, and use these as means of adjustment, by forcing them with set-screws in the one or the other direction; or a single pin can be utilized, bringing the points of the set-screws to bear on either side of it.

An interesting case of the employment of taper strips in combination with ordinary side-set strips is illustrated in Fig. 43. The saddle has a central boss and hole, which forms the receptacle for a work spindle (the machine being a gear-hobber), and as this hole must be maintained in a central position, three sets of gibs are fitted. By suitable adjustment of the wedges and the outer strips, the saddle can be kept in the precise position intended.

* * *

BAR SUPPORT AND STOCK RACK FOR THE SCREW MACHINE

The accompanying illustration shows an interesting bar support for an automatic screw machine, this combination support and stock rack being used in the Wells Bros. Co.'s plant, Greenfield, Mass. The principal feature is that the stand serves both as a support for the bar being worked upon in the machine and also as a stock rack for the bars to be subsequently fed to the machine. It is not unusual in screw machine shops to see the stock kept underneath the machine, supported by the brace between the legs of the machine, or placed on the floor behind or underneath the machine. This method of keeping the stock is not convenient, nor does it look neat or orderly.



A Convenient Bar Support and Stock Rack used in the Wells Bros. Co.'s Shop, Greenfield, Mass.

By using bar supports of the form shown in the illustration, the double purpose of providing a place where the stock can be kept near the machine in the proper manner, and of weighing down the bar support, so as to prevent that nerve-racking noise, due to the shaking of the supports, so commonly heard in screw machine shops, is obtained. The bar support itself is provided with two rollers supporting the stock as shown, and also with two rollers on the top to prevent the stock from chattering in the support. These upper rollers are held in an adjustable holder as shown, and the upper part of the bar guide is provided with a swinging joint, so that it can be swung out of the way by merely loosening the nut on the locking screw in the front, and swinging the bolt forward—a construction familiar to all jig designers. This type of stock rack and bar support has been found very convenient and useful in the shops mentioned.

* * *

The statement that England has a new lighthouse, all the mechanism of which is electrically controlled by the keeper, who lives on shore a mile away, conveys a world of meaning to the engineer. The accomplishment represents in a nutshell, so to speak, the great advances made in distant control of mechanism by electrical agency. Although the spread of the idea may rob the seashore of some of its romance, it surely will mean a great gain in the personal comfort of lighthouse keepers. Isolation of the most dreary sort will no longer be the lot of keepers of the beacons on the sea.

THE USE OF BARIUM CHLORIDE FOR HEATING STEEL FOR HARDENING

As is well known, high-speed steel requires to be heated to a much higher temperature for hardening than does ordinary carbon steel. While a heat of from 1400 to 1600 degrees F. is sufficient for tools made from carbon steel, a heat of from, at least, 1800 to 2200 degrees F. is required in order to satisfactorily harden high-speed steel tools. The ordinary lead bath commonly used for heating carbon steel tools cannot be used at such high temperatures as these, and as it is, in general, unsatisfactory to heat the tools in an oven furnace, owing to the difficulty of correctly determining the hardening temperature when the tools are heated in this way, some heating medium has been sought which could stand high temperatures and in which the pieces to be hardened could be immersed so as to obtain a uniform heat without danger of burning delicate points or cutting edges—a danger which is always present when high-speed steel tools are heated to a high temperature in an open heating furnace. It has been believed that a satisfactory heating medium had been found in barium chloride, and this medium has been, and is still, used to a considerable extent both in this country and abroad; but the results obtained have not been as favorable as was at first expected, and many users of barium chloride have abandoned its use on account of the difficulties met with.

It appears that tools heated for hardening in a crucible containing barium chloride have a soft scale or film of soft metal, perhaps about 0.003 to 0.006 inch deep, all over the surface of the tool. Careful experiments have been made to ascertain as nearly as possible the conditions which contribute to produce such unsatisfactory results. Comparison has been made between tools made from the same material of which some were hardened by heating them in barium chloride and some in an oven furnace. The results of these experiments are recorded in the following.

TABLE SHOWING THE HARDNESS OF HIGH-SPEED STEEL HEATED FOR HARDENING UNDER DIFFERENT CONDITIONS

Heat of Hardening Bath, Degrees F.	Heated in Oven Furnace			Heated in Barium Chloride			
	Time Test Piece was Left in Furnace, Minutes	Degree of Hardness on Scleroscope Scale		Left in Bath 10 Minutes: Degree of Hardness on Scleroscope Scale		Left in Bath 18 Minutes: Degree of Hardness in Scleroscope Scale	
		Face of Test Piece	Back of Test Piece	Face of Test Piece	Back of Test Piece	Face of Test Piece	Back of Test Piece
1700*	9½	Soft	Soft	Soft	Soft	Soft	Soft
1800	7	83.5	85	92	91	93	90
1900	6	91	86	93	91	91	92
2000	6	90	86	91	87	92	89
2100	5½	90	91	91	82	87	74
2200	5	93	91	88	82	86	70
2300	4¾†	93	93	73	64	74	62
2400	3½	92	93	65	65	63	57

* At this temperature the steel would not harden, and, therefore, no scleroscope tests were made.

† This sample was burnt and pitted, indicating that it had been kept in the fire too long.

In order to make the tests as simple, and at the same time as conclusive, as possible, pieces of high-speed steel, ½ inch thick, were cut off from one bar of steel. These pieces were hardened by heating some of them in a common oven furnace, and others in barium chloride melted in a graphite crucible placed in a gas furnace. The pieces were heated directly from the room temperature to the hardening temperature, no pre-heating being resorted to. The barium chloride used was chemically pure. The temperatures were recorded by a Bristol pyrometer, and the hardness tests were made on a Shore scleroscope. After heating, the pieces were immersed in a cooling bath consisting of cottonseed oil at a temperature of 100 degrees F. The temper was then drawn in an oil tempering bath at 500 degrees F., a temperature which is not too high for the higher grades of high-speed steel, although it would be excessive for ordinary carbon steel.

When the pieces were heated in the oven furnace, the operator, an experienced hardener of this kind of steel, used his own judgment as to when to remove the piece from the furnace and plunge it into the hardening bath, but the time required for the piece to acquire proper hardening heat was recorded, and is given in the accompanying table. The degree of heat as given, is the heat of the furnace as recorded by the pyrometer, but it is evident that in the case of a piece of steel heated in an oven furnace and removed according to the judgment of the operator, there may be a slight variation between the heat of the furnace and the heat of the piece itself. When the tools are heated in the barium chloride bath, the temperature of the piece and the bath will, of course, be the same, provided the piece is permitted to remain in the bath long enough, which was the case in the experiments described.

After the pieces had been hardened and tempered as described, an amount equal to 0.005 inch was ground off from one side of the pieces, which we will call the face, and an amount of 0.002 inch was ground off from the other side, the back. The surfaces presented to the scleroscope were thus perfectly smooth and uniform, but it should be noted that less of the soft scale, mentioned in the foregoing, was removed from the back of the pieces than from the face. The pieces were now subjected to scleroscopic tests, carefully recorded and repeated several times. The results of these tests are given in the accompanying table, the values given being the average of the several readings.

It should also be mentioned that the pieces heated in the barium chloride at 2100 to 2400 degrees F. were found to be pitted, and small beads of a metallic structure adhered to the pieces. Similar small pieces were found in the bottom of the crucible after all the test pieces had been hardened. This residue was chemically analyzed and was found to consist principally of ferro-tungsten, the analysis showing tungsten, iron and carbon to be present. The carbon content was about 3.3 per cent, tungsten 9.8 per cent, and iron 86.9 per cent.

Several interesting and instructive conclusions with relation to the heating of high-speed steel in an oven furnace, and the action of barium chloride as a heating medium for high-speed steel when hardening, may be drawn from the results recorded in the table. It will be seen that when heating in an oven furnace, the results obtained were almost uniformly better according to the heat at which the pieces were hardened. The higher the heat, the higher the scleroscopic test number. This result is in thorough harmony with the general principle that the higher the heat at which high-speed steel tools are hardened, the better their cutting and "standing up" qualities. When the pieces were heated in barium chloride, however, a result entirely different was obtained, and at temperatures of 2100 to 2400 degrees F., the results were, in general, very unsatisfactory. In the case where the pieces were permitted to remain 18 minutes in the heating bath it will be seen that the face of the piece is almost uniformly softer, the higher the hardening heat. This may be taken to indicate that there still was some of the soft scale left, even after having removed an amount equal to 0.005 inch by grinding. A file test on the surface, however, could not detect this scale, as the surface seemed glass-hard.

The feature which will particularly be noticed in studying the table is that in almost every case the back, where only an amount of 0.002 inch was removed, is softer than the face of the test piece. It is evident that this is due to the fact that the soft scale is deeper than 0.002 inch, and has not been entirely removed by the grinding on the back; whereas the face where an amount of 0.005 inch has been ground off, is practically freed from the soft scale, and hence shows a greater hardness when tested by the scleroscope. The influence of this soft film is especially apparent when the steel is hardened at a temperature of 2100 to 2400 degrees F.

Having ascertained through the tests mentioned that barium chloride had a detrimental influence upon the hardness of high-speed steel heated in it at high heats (2100 to 2400 degrees F.), tests were next made to ascertain the in-

fluence on the cutting qualities of tools hardened either by heating in barium chloride or in an oven furnace. These tests proved conclusively that the tools heated in the barium chloride bath did not stand as high a cutting speed as did those hardened by heating in an oven furnace. The ferro-tungsten found in the bottom of the crucible indicates that, particularly at high heats, some of the tungsten and carbon is removed from the tools into the bath, thus changing the structure of the surface of the tool being heated. When an amount of, say, 0.010 inch is ground off from the cutting edges of tools, the influence of the heating in barium chloride is less noticeable—in fact, sometimes not noticeable at all—but when the tools cannot be ground after hardening, barium chloride is not a heating medium which can be recommended under any circumstances. The change of the structure on the surface of the tool explains why tools heated in barium chloride cannot stand up at as high speeds as those heated in an open fire.

Another disadvantage met with in the use of barium chloride is that the residue of ferro-tungsten found in the bottom of the crucible seems to have a deteriorating influence on the crucible, "eating" through it in a comparatively short space of time. As a general conclusion it may be stated that whenever barium chloride is used as a heating bath, it should never be permitted to reach a temperature of more than 2050 degrees F.

Barium Chloride in the Electric Hardening Furnace

The difficulties met with in the use of barium chloride in a crucible heated in a gas furnace are still further accentuated when using an electric hardening furnace of the type employing a barium chloride bath as the heating medium.

When steel is heated in barium chloride in an electric furnace, the current apparently passes directly through the steel and the pieces are heated not only by the heat imparted to them from the barium chloride bath, but also by the resistance to the electric current passing through the steel itself. That this must be the case is indicated by the fact that tools heated in an electric furnace are brought up to the proper temperature for hardening in approximately one-third of the time which is required for heating them in a barium chloride bath of the same temperature contained in a graphite crucible heated in a gas furnace. As an example it may be mentioned that certain tools which must remain sixteen minutes in a barium chloride bath in a gas furnace can be heated in the bath in the electric furnace in from four to five minutes. The barium chloride bath in an electric furnace does not cool down to the same extent when the pieces to be hardened are immersed, as does the heating bath in the gas furnace. This also indicates that in the electric furnace the heat required for bringing the steel to a hardening temperature is only partly derived directly from the bath in the electric furnace; while all of the heat required must be given out by the barium chloride bath in the crucible in the gas furnace. These facts make it conclusive that there is an entirely different action in the heating of steel immersed in a bath of the same character in an electric furnace than there is when it is immersed in a bath contained in a graphite crucible. The rapidity with which tools to be hardened can be heated in an electric furnace has been quoted as one of its principal advantages, and so it would be were it not for the fact that the surface of the steel deteriorates under the action of the bath, the bath in turn deteriorating under the action of the electric current.

On tools which are ground after hardening, there does not seem to be any difference between the hardness of those which have been hardened in barium chloride in a crucible and those heated in the same medium in the electric furnace. The tools can be run at the same cutting speed and will stand up equally well; but when the tools cannot be ground on the cutting edges as in the case of formed milling cutters, knurls, taps, dies, etc., then the tools heated in the electric furnace are decidedly inferior, especially under certain conditions which will be more thoroughly explained in the following, there being a thin scale or film on the outside which is entirely too soft to possess proper cutting qualities.

Experiments have been undertaken in order to determine, to some extent at least, the causes of the difficulties met with in heating tools in the electric hardening furnace. No conclusive answers can, perhaps, be given to all of the questions which may be asked in this connection, but the results of the experiments give at least a clue to the cause of the trouble, and further experiments might be made which would give still more conclusive results; if methods can be developed which will remedy the defects and make it possible to heat steel in a barium chloride bath in an electric furnace without having to contend with the soft scale on the surface of the steel, the electric furnace would present the best means for heating tools in a bath of high temperature, on account of the decided difference in the time required to bring the tools to the proper hardening temperature.

It has been found that barium chloride when used in a graphite crucible in a gas furnace slightly deteriorates when it has been used for a number of days; but the difference in the results obtained when heating in a bath of entirely new barium chloride and a bath which has been in use for several days, say from six to ten days, is so small that ordinarily no attention need be paid to it. Some users of the barium chloride bath, however, have been in the habit of changing the bath every day, using new barium chloride at all times. This practice is, of course, very expensive, and the advantages gained are too small to warrant the added cost. When barium chloride is used in an electric furnace, however, it deteriorates very rapidly, so that it is practically useless for its purpose after a couple of days' use, and after having been used for a week it may be stated without exaggeration that it is entirely unsuited for any further use. Furthermore, the barium chloride which has been used in a graphite crucible has not retained its almost white color after several days of use, whereas that used in the electric furnace is of a dark gray color. This difference in color is apparently due to the fact that the barium chloride in the electric furnace dissolves the ferro-tungsten which, as previously mentioned, is found in the bottom of the crucible when heating steel in a gas furnace; or possibly the soft iron electrodes are partly dissolved by the barium chloride. The absence of a precipitate in the electric hardening furnace and the gray color of the bath would seem to make it safe to draw this conclusion.

As regards the deterioration of the barium chloride after a few days' use in the electric furnace, several interesting facts have been noted. When steel is hardened after having been heated in a bath consisting of new barium chloride which has been used but one or two days, it seems to acquire a satisfactory hardness, at least as satisfactory as when heated in the same kind of a bath in a crucible heated in a gas furnace. There is, of course, a very thin soft scale, the same as on all tools heated in a barium chloride bath, but this scale is so thin that it cannot be detected with a file test, and hence can be considered of no consequence. After the first day or two, the influence of the barium chloride in conjunction with the electric current on the surface of the steel is considerably augmented; and when the barium chloride has been in use in an electric furnace for about a week, a scale from 0.005 to 0.010 inch deep can be easily detected. A scale of this thickness, of course, makes it impossible to use this means for heating the steel in any case where the cutting edges of the tools cannot be ground off to a sufficient depth to entirely remove the soft outside portion. In the experiments made, the steel was heated to a temperature of about 2100 degrees F.

It was thought that possibly some other factors besides the barium chloride, which had been in use for a number of days, were the cause of the soft scale found on the tools. New barium chloride was, therefore, melted in the furnace, and a new set of tests made. In these tests the results obtained in the first series were entirely duplicated. During the first two days the steel hardened had no perceptible soft film or scale; but when the bath had been in use for about three or four days there was a pronounced soft scale, and after a week the scale had a thickness practically the same as in the first series of tests.

While, as already mentioned, no indications of the presence of ferro-tungsten were found in the bottom of the electric

furnace, a soft, dark gray precipitate was found in the bottom of the electric furnace pot when it had been run with the same bath for about a week. The electrodes of the electric furnace are made of soft iron, and it is likely that the precipitate found originates from the electrodes, as it proved to be a metallic substance similar to iron, and soft enough so that it could be easily filed, which, of course, would not have been the case had the precipitate consisted of ferro-tungsten.

Another interesting fact has also been noticed in connection with the electric furnace. The amount of barium chloride used in a given time is much greater in an electric furnace when the bath is heated to a given temperature, than it is in a gas furnace with a bath at the same temperature. For some reason the electric current passing through the bath seems to make it easier for the molten salt to volatilize.

The makers of electric hardening furnaces may undertake experiments which will give more complete data relating to the action of barium chloride in an electric furnace than those brought forth in the foregoing. At present, however, it seems that barium chloride is unsatisfactory for hardening high-speed steel in an electric furnace, and that it has only a comparatively limited application when used in crucibles and heated in a gas furnace. Some users of barium chloride baths for heating tools for hardening have, as mentioned, entirely abandoned its use after several attempts to make it successful, while others still continue its use for parts and tools on which a thin soft scale is not objectionable and can be removed by grinding.

One important question to be solved is whether the barium chloride after having deteriorated to a point where it is unfit for further use, can be easily and by some cheap method restored to its original condition. In this case the process using barium chloride would still have a considerable field. A satisfactory reason should also be found for the consumption of a greater amount of barium chloride in the electric furnace than in a gas furnace. The added consumption of the barium chloride adds considerably to the expense of running the furnace, although it must be admitted that this added expense is to a large extent compensated for by the rapidity with which tools can be heated in the electric furnace.

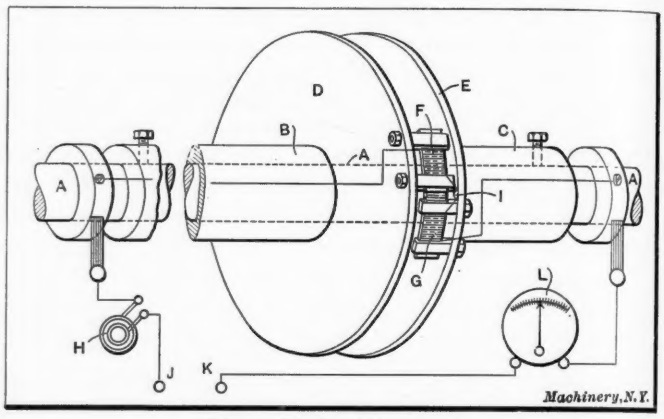
These questions, if they can be answered, probably will be answered by the makers of electric furnaces, and while some defects of the present methods of heating tools in furnaces of the type using barium chloride for a heating bath have been pointed out, it is not intimated that these furnaces cannot be made a success. It must be remembered that they have been on the market a comparatively short time, that the electric hardening furnace is a comparatively recent development, and that when enough time and energy have been spent on the thorough development of this device, it may prove satisfactory. It should also be noted that in speaking of an electric heating furnace, only those furnaces using a barium chloride bath for the heating medium have been referred to. Other electric heating furnaces are made, in which no heating bath is used, but the steel is heated in the air between two electrodes. This type of electric heating furnace is in a class by itself, and while it presents some difficulties, they are of a minor nature and do not come under the head of the present investigation.

It should also be understood that the electric hardening furnace, using a barium chloride bath, has a wide field of usefulness for heating ordinary carbon steel tools for hardening, as in this case hardly any of the objections mentioned in the foregoing, and which apply to the hardening of high-speed steel only, are present, except the increased consumption of barium chloride and potassium chloride, with which latter salt the barium chloride must be mixed when used for heating carbon steel. This mixture is necessary in order to obtain the lower melting temperature of the bath required for carbon steel. The advantages of the electric hardening furnace for carbon steel tools are the greater rapidity with which they can be heated and the clean white surface on the tools thus hardened. The cutting edges of the tools seem to be protected by the coating from the heating bath which falls off when the tools are dipped. When dipping in an oil bath, this coating is not entirely removed, but it always disappears when dipping in hot water or soda solution.

ELECTRICAL TORSIOMETER

An interesting application of the electrical transformer principle is the basis of U. S. patent No. 979,503 (December 27, 1910), issued to Chas. H. Johnson, Dumbarton, Scotland. The device, which is a torsiometer for measuring power, is diagrammatically represented in perspective in the accompanying engraving.

The torsiometer is mounted on a shaft *A*, it being desired to ascertain the power being transmitted by this shaft. On this shaft are two loose sleeves *B* and *C* secured at their outer ends by set-screws, as shown. On the inner ends of these sleeves are two disks *D* and *E*, to which are attached on their inner side the two electro-magnets *F* and *G*, respectively, the pole faces of these coils being in close proximity to each other. The coil *F* is electrically energized from a generator *H*, the circuit being completed by grounding the ends *I* and *J*. This generator may be either alternating or continuous; if it is



Patented Electrical Torsiometer

continuous, suitable means must be provided for breaking the current, thereby making it intermittent. In either case the coil *F* causes an induced current to flow in coil *G*, which may be registered by the meter *L*, the circuit being closed by grounding at *I* and *K*.

As the shaft revolves, its torsion causes the coils *F* and *G* either to draw further apart or nearer together, depending upon the direction of rotation. The current induced in coil *G* by coil *F* depends upon the size of the intervening air gap between the coils, so that for every torque, there will be a different current to be recorded by the instrument *L*. Also, if the generator *H* be connected in some way to the shaft *A*, its current will change with the speed, if properly wound. It can thus be seen that the instrument can be calibrated to not only indicate torque as represented by the torsion of the shaft, but also power, as the speed factor is introduced through the varying current generated at different speeds by the generator *H*.

The patent also covers the use of this principle in other applications, as, for example, the measurement of compression and elongation, and similar uses.

* * *

AUTOMATIC MACHINERY AS A CHEAPENING FORCE

The sewing machine is one of the great labor-saving inventions of the age. Hundreds of thousands are made annually and sold all over the globe. A recent editorial visit to one of the large sewing machine maker's plants demonstrated to what an extent the automatic screw machines have made possible the making of good sewing machines that sell for $15 to $20. In this factory there are three hundred screw machines and twelve hundred operatives. The daily product is five hundred machines. The fact that a sewing machine is produced with the labor of one person for two and four-tenths days is marvelous. With the labor equivalent of two and four-tenths days of an individual, a machine is produced that will sew more stitches in an hour than the hand operator can take in three days of ten hours each, and much better at that. The automatic machine is the chief contributing cause of this development of manufacturing that puts to shame the marvels of Aladdin's wonderful lamp.

ELECTRIC MOTOR SUPPORTS

By J. H. CARVER*

When installing a motor to drive a lineshaft, or as an individual drive to some machine, the style, and sometimes the dimensions of its support are among the questions to be decided upon. The following shows the practice of one of the leading manufacturers in regard to supporting motors:

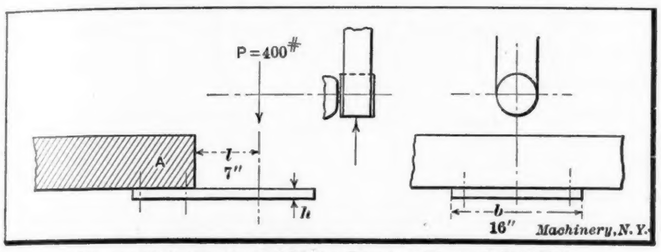


Fig. 1. Plain Sheet-steel Motor Support, Upward Belt Pull

Fig. 1 shows a plain steel plate where A is a machine part, a structural shape or any practical support for the plate. The dimensions of the motor feet and bolt centers, of course, determine the lateral dimension, and its thickness depends on

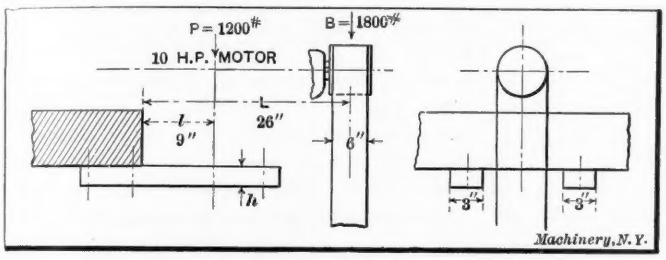


Fig. 2. Motor Support made of Machine-steel Bars, as Belt Pull is downward

the weight of the motor and the direction and size of belt. If the belt pull is upward as shown, the weight of motor need only be considered, as the belt tension lessens the load on the plate. With this condition the thickness of plate is found by the beam formula $M = SZ$ where M = bending moment,

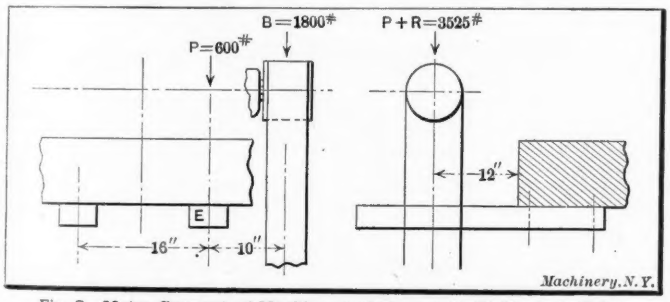


Fig. 3. Motor Support of Machine-steel Bars, with Right-angle Drive

S = unit stress, and Z = section modulus. Here the beam is cantilever, and $M = Pl = SZ$.

$$Z = \frac{b\,h^2}{6}$$

for a rectangular section. Then

$$P\,l = \frac{S\,b\,h^2}{6}$$

or

$$h^2 = \frac{6\,P\,l}{S\,b}$$

If P = 400 pounds, l = 7 inches, S = 8000 pounds, and b = 16 inches, then

$$h^2 = \frac{6 \times 400 \times 7}{8000 \times 16} = \frac{21}{160} \text{ and } h = \text{say } \tfrac{3}{8} \text{ inch}$$

Fig. 2 shows the conditions with belt pull considered. If the belt pull is at an angle from the horizontal, tending to pull downward, it may be considered practically a downward pull and its value is the area of the two thicknesses of belt multiplied by the working stress on the belt, for which a good average is 400 pounds per square inch; this considers the tensions to be alike on both sides. For heavy motors, plates must be comparatively thick and are difficult to machine to size; so for this reason bars of machine steel are preferred. This gives as in Fig. 2 a cantilever with two concentrated loads. The pull of the ⅜-inch belt is $2 \times 6 \times \frac{3}{8} \times 400 = 1800$ pounds $= B$. As before $M = SZ$ or $BL + Pl = SZ$.

$$Z = \frac{b\,h^2}{6} \text{ and } B\,L + P\,l = \frac{S\,b\,h^2}{6}$$

or

$$h^2 = \frac{6\,(B\,L + P\,l)}{S\,b}$$

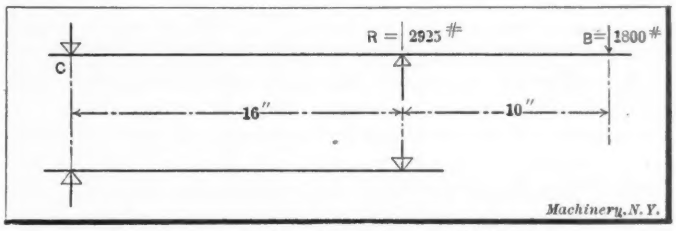


Fig. 4. Representation of Conditions existing in Fig. 3.

where $b = 6$ inches for both bars.

Then

$$h^2 = \frac{(1800 \times 26) + (1200 \times 9)}{8000} = \frac{576}{80}$$

say 2½ inches as the thickness of each supporting bar.

Fig. 3 shows the same motor on bars as in the last case,

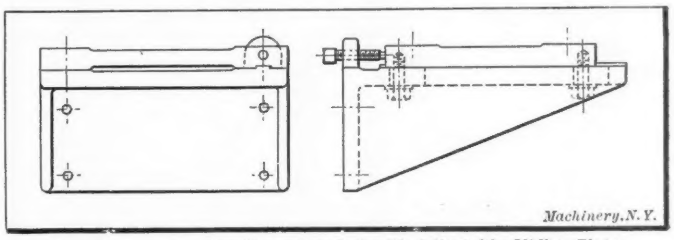


Fig. 5. Cast-iron Cantilever Bracket with Adjustable Sliding Plate

but with the motor placed at right angles. The bar E will receive most of the load as found by the method of moments shown in Fig. 4. Taking moments about C,

$$16R = 26 \times 1800 \text{ or } R = \frac{26 \times 1800}{16} = 2925 \text{ pounds}$$

and this added to half the weight of the motor gives the condition shown in Fig. 3 of a cantilever with load $P + R$ at a distance 12 inches from the support.

Fig. 5 shows an ordinary cast-iron cantilever bracket which is frequently used, the channel section shown having proved

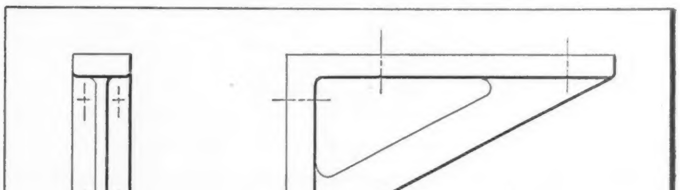


Fig. 6. Plain Cast-iron Bracket, to be used in Pairs, with or without Sliding Plate

to be the cheapest and strongest. The sliding plate takes care of belt tension and is provided with a tongue on one side only to preserve alignment, and has tapped holes to receive bolts through the bracket. The motor bolts are, of course, tapped into the sliding plate only. If provision for belt tension is not needed, the plate may be done away with, or it may be omitted and belt tension still cared for in the casting by machining slots in the bracket for through motor bolts.

Fig. 6 shows a bracket which may be used in pairs—alone or in combination with a sliding plate for belt tension adjustment. They have the advantage of being light and one pattern does for both castings.

* Address: 761 Eastern Ave., Schenectady, N. Y.

Fig. 7 shows angles used on a wooden or structural steel column. Suppose the motor is 3 horsepower, weighs 600 pounds and with its center of gravity 20 inches from the support. By this construction there are two angles used as cantilevers, each with a load of 300 pounds, 20 inches from

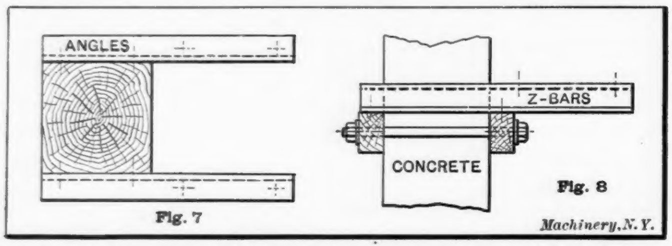


Fig. 7. Angle Support for Attaching to Wooden or Structural Steel Column. Fig. 8. Z-bar Support for Concrete Columns where Bolts are not incorporated in Original Column

the support. First try 3-inch angles to suit the dimensions of motor feet. In a handbook can be found the value of $\frac{I}{e}$ for the lightest angle. This has equal legs ¼-inch thick, weighing 4.9 pounds per foot. Then

$$Pl = \frac{SI}{e} \text{ or } S = \frac{Ple}{I}$$

where $S =$ unit working stress, which may be as much as

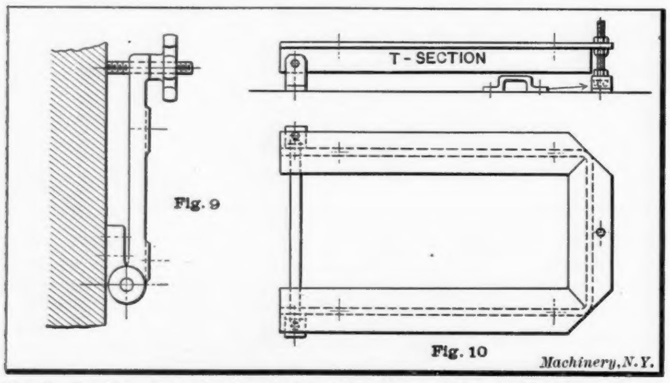


Fig. 9. Cast-iron Swinging Bracket for Attaching to Side of a Machine. Fig. 10 Swinging Bracket constructed of Structural Steel T-Sections

10,000 pounds per square inch on this sort of work, $P =$ load in pounds, $=$ moment of inertia, and $e =$ distance from neutral axis to outermost fiber.

If $P = 300$ pounds, $l = 20$ inches, $I = 1.24$ and $e = 0.84$, then

$$S = \frac{300 \times 20 \times 0.84}{1.24} = \text{say } 4070 \text{ pounds, which is a safe}$$

working stress.

Fig. 8 shows an arrangement of a support for light motors,

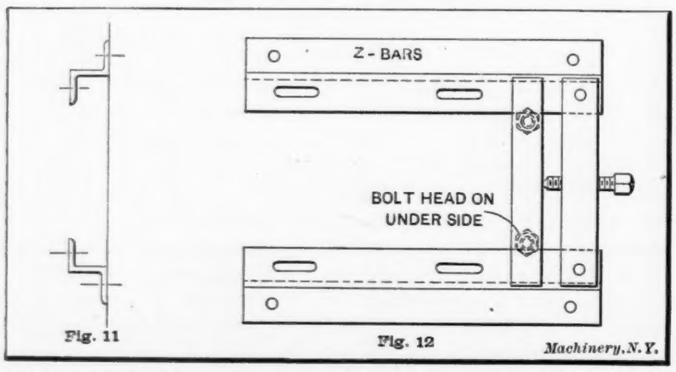


Fig. 11. Z-bar Method of Supporting Motor above the Floor. Fig. 12. Z-bar Method of Support similar to that in Fig. 11, only with the Adjustable Feature

say not over 3 horsepower on concrete columns, where bolts were not originally provided for the Z-bars.

Fig. 9 shows an arrangement for use on sides of machines with provision for adjusting belt tension.

Fig. 10 shows a swinging bracket of T sections of structural steel, bent as shown. Two triangular pieces must be cut from one leg to admit of bending. This bracket can be used to good advantage on any machine where a direct drive from floor to machine can be had. It of course takes care of belt tension. The U-shaped piece shown on the floor can be made from two short Z-bars, with lag screws to hold them down.

Fig. 11 shows a cheap method of keeping a motor off the floor, and permits of that part under the motor being kept clean. Two Z-bars whose sizes are determined by dimensions of motor feet are held by lag screws or other fastenings accord-

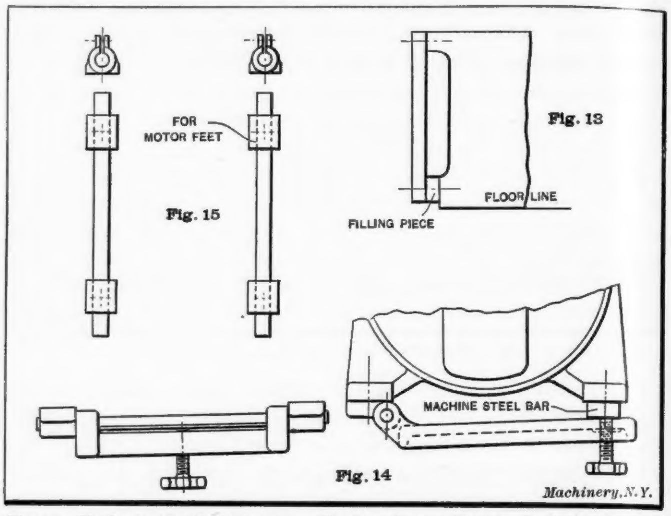


Fig. 13. Method of Bolting Motor to a Machine Tool. Fig. 14. Swinging Bracket for Use where there is Room for Handwheel. Fig. 15. Pipe Motor Support

ing to the nature of the floor material. Slots can be machined in them to take care of belt tension.

Fig. 12 shows the same arrangement with more attention given to adjustment, the Z-bars having two machine-steel bars on top, one bolted and the other movable, with adjusting screw as shown. The movable bar has two bolts screwed in

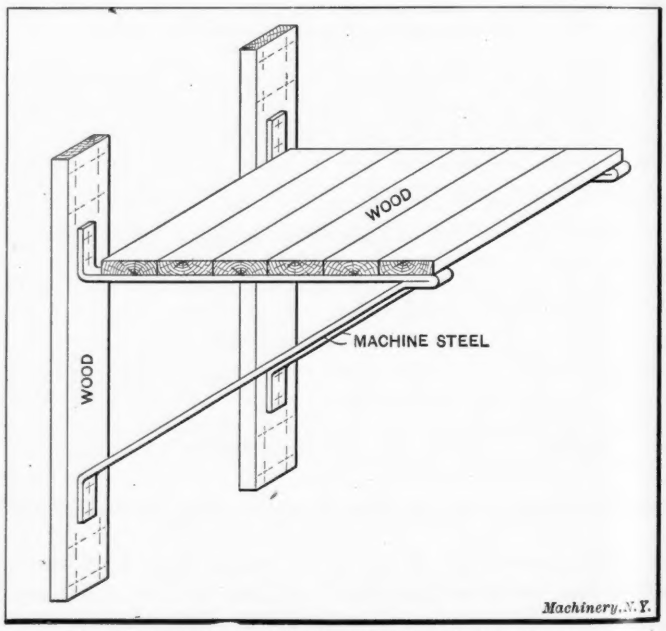


Fig. 16. Bracket for Brick Wall made of Bar Machine Steel and Wood, for Heavy Motors

from the under side with a snug fit in the threads, the bar and bolt heads running loose on the leg of the Z-bar. The bolts merely keep the sliding bar from falling off.

Fig. 13 shows a method of bolting a motor to the back of a lathe, or other machine tool, sometimes used when placing a motor drive on a belt-driven machine. Two bars of machine steel are used with the filling piece shown, if necessary.

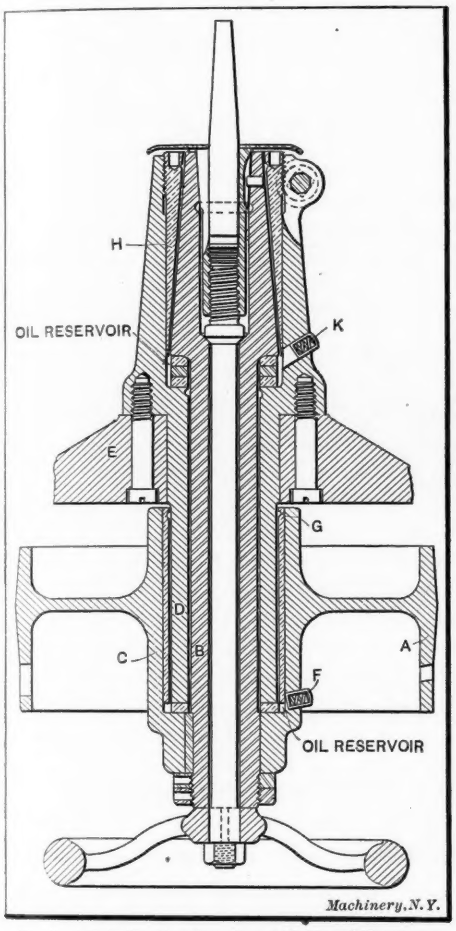
Fig. 14 shows an arrangement where room can be had for a small hand adjustment wheel. The bar of machine steel is bolted to two of the motor feet, and must be stiff enough to resist half the weight of the motor when belt pull is not considered.

Fig. 15 shows a method where pipes can be used on such places, as between machine legs, etc. One pattern does for the four castings which are cored a little above pipe size. They then require no machining and are held by set-screws, the castings being split.

Fig. 16 shows the construction of a brick wall bracket used for heavy motors. It is made up of bent machine steel diagonals and a wooden platform.

INTERESTING VERTICAL SPINDLE CONSTRUCTION

A machine made by the Billings & Spencer Co., of Hartford, Conn., and intended especially for milling the cutting edges of trimming and punching dies, was illustrated in the November, 1908, issue of MACHINERY. During a recent visit to the plant of this company, the writer's attention was called to the interesting spindle construction used on this machine, this construction being illustrated in the accompanying engraving. The difficulty met with in the design was that on account of the vertical position of the spindle, it was difficult to properly oil the bearings, the oil having a natural tendency to flow downward. By the arrangement adopted, this difficulty has been overcome, and a satisfactory means for oiling the vertical spindle bearings has been obtained.



Vertical Spindle Construction with Novel Features

In the illustration, *A* is the driving pulley which is keyed to spindle *B*. The driving pulley is provided with a bronze bushing *C*, and revolves upon the stationary sleeve *D*, which is fastened to the frame *E* of the machine. Clearance is provided between spindle *B* and sleeve *D*. The oil for lubrication between bushing *C* and sleeve *D* is introduced at *F*, where it enters an annular oil reservoir. A spiral groove is cut on the sleeve, the direction of the spiral being the same as the direction in which the pulley revolves, so that the oil is practically pumped up along the surface of the sleeve. At the upper end of the bushing a small half-circular groove is cut, as indicated at *G*. This groove acts as an upper reservoir for the oil, from which it has a constant tendency to descend by gravity. The two forces acting upon the oil—the one due to the pumping effect along the spiral groove upward, and the tendency to flow by gravity downward—seem to balance each other, so that a very satisfactory lubrication of the bearing has been obtained without excessive use of oil.

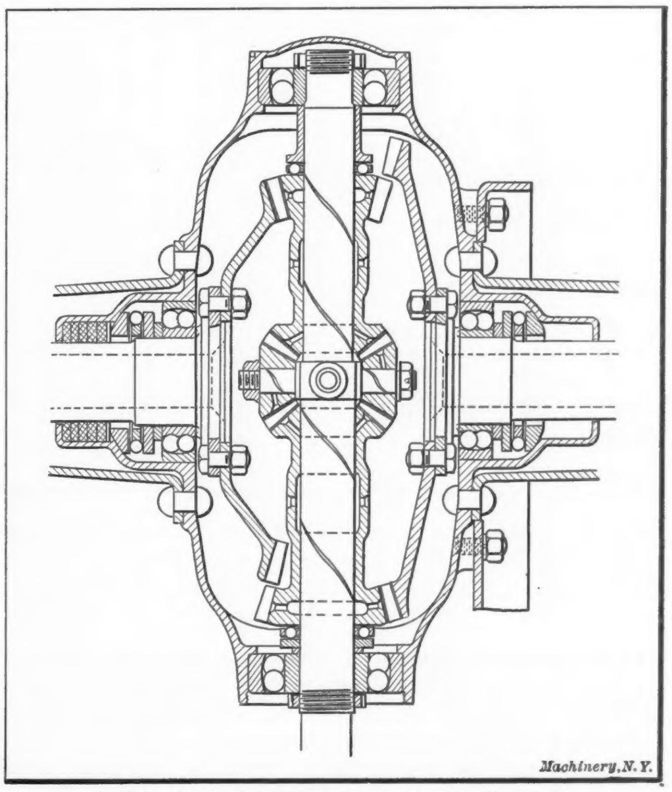
The lubrication of the bearing between the upper tapered end of the spindle *B* and the bronze spindle bushing *H* is accomplished in the same manner. The oil is introduced at *K*, and enters the reservoir; from here it rises by means of a spiral groove cut on the spindle, until it reaches the small annular groove at the top. It is, of course, necessary to remember that in constructions of this kind satisfactory results can be obtained only if the spindle rotates constantly in the same direction, because the spiral groove must be right-hand, for example, when the spindle rotates in a right-hand direction and *vice versa*. If the direction of the spiral of the oil groove were opposite to that of the direction of rotation of the spindle, the tendency would be to force the oil down instead of up, and the object sought would be entirely defeated. It is possible that in the case of a reversible drive, one right-hand and one left-hand spiral groove would prove satisfactory, but this arrangement has not been actually tried. The construction is an interesting one and may be found useful in many cases where difficulty has been experienced in oiling vertical spindle bearings.

* * *

AUTOMOBILE DIFFERENTIAL ON THE PROPELLER SHAFT

The illustration shows a departure in automobile transmission gear design brought out in the La Buire automobile (Lyons, France) a year ago that is of considerable general interest to machine designers, because of the principle developed. The differential mechanism is placed in the propeller shaft where it runs at a relatively higher speed than when mounted on the rear axle in the usual manner. The unit pressure on the differential gear teeth is proportionally reduced, making a lighter and more durable construction possible. The improvement has the disadvantage of making two large bevel gears on the axle and two bevel pinions on the propeller shaft necessary. The following description is taken from *The Car*.

"The propeller shaft, instead of terminating as usual with the small driving bevel pinion, is extended right through the differential case from end to end. Double ball races support the shaft at both extremities. In the center of the shaft, and therefore of the differential case, are four trunnions, which are made in one piece with the shaft. These trunnions carry four beveled satellites which transmit the drive to double driving bevels, the latter being connected by sleeves running loose on the shaft. From the double driving bevels power is transmitted to two crown wheels, which are bolted onto the inner ends of each of the live axles. One of the double driving bevels and one crown wheel are smaller than the other bevel and crown wheel but are of the same ratio, so that each live axle is propelled at exactly the same speed."



La Buire Automobile Differential on the Propeller Shaft

* * *

The competition in the manufacture of small gas engines is keen and the need of specialized knowledge of machine tools and manufacturing methods is perhaps as great as in any other line, but "Fools rush in where angels fear to tread." A concern in the Middle West, making farm machinery recently began the building of gas engines. The manager canvassed some of the machine tool builders for certain machines required in his shop, and in the interview with one it developed that he had never seen or even heard of a micrometer!

HOLLOW SHAFTS

By E. HAMMARSTROM*

In the following article is given a simple method for finding the dimensions of a hollow shaft which can be substituted for a solid shaft of equal strength to resist bending or torsion.

Let D_1 = diameter of solid shaft,
D = outside diameter of hollow shaft,
d = inside diameter of hollow shaft,

$$t = \frac{D - d}{2} = \text{thickness of metal of hollow shaft,}$$

$$k = \frac{d}{D} = \text{ratio of diameters of hollow shaft.}$$

As the hollow shaft is to have the same strength to resist bending as the solid shaft, the moment of resistance of both must be equal. Hence:

$$\frac{\pi (D^4 - d^4)}{32 D} = \frac{\pi D_1^3}{32}$$

from which

$$D^3 - \frac{d^4}{D} = D_1^3 \qquad (1)$$

If $k\,D$ is substituted for d in Equation (1), we have:

$$D^3 - D^3 k^4 = D_1^3$$

from which

$$D = D_1 \sqrt[3]{\frac{1}{1 - k^4}}$$

and

$$\frac{D}{D_1} = \sqrt[3]{\frac{1}{1 - k^4}} \qquad (2)$$

In a similar manner, by substituting $\frac{d}{k}$ for D in Equation (1), we obtain:

$$\frac{d}{D_1} = k \sqrt[3]{\frac{1}{1 - k^4}} \qquad (3)$$

Further, as $t = \frac{D - d}{2}$, we get by substitution and simplification of the expressions:

$$t = \frac{D_1}{2} (1 - k) \sqrt[3]{\frac{1}{1 - k^4}}$$

or

$$\frac{t}{D_1} = \frac{1 - k}{2} \sqrt[3]{\frac{1}{1 - k^4}} \qquad (4)$$

In the accompanying table the values of the factors containing k in Equations (2), (3), and (4) are calculated for certain values of k. The bottom line of the table gives the weight of the hollow shaft in per cent of that of the solid.

It is evident that Equation (1) would be the same, if it were derived under the assumption that the hollow shaft had the same torsional strength as the solid one, instead of having the same strength against bending, as assumed. The table will therefore hold true for shafts subjected to bending or torsion or both.

Assume, as an example, that a solid shaft 3 inches in diameter is to be replaced by a hollow shaft, ratio k being 0.5. Then, by inserting the value found from the table in Equation (2) we have:

$$\frac{D}{D_1} = 1.0216 \text{ and } D = 3 \times 1.0216 = 3.065 \text{ inches,}$$

$$d = 0.5\,D = 1.532 \text{ inch.}$$

* * *

In a series of tests conducted by Italian engineers it has been found that bearing bronzes containing a high percentage of tin are too hard for bearing purposes, and that only such bronzes as contain 10 per cent or less of tin are suitable.

* Address: 85 Third Place, Brooklyn, N. Y.

PRESSURE VS. LOAD

The boy who figured that he could lift himself into the clouds by exhausting the air from a small piece of gas pipe capped at the ends, because air pressure is fifteen pounds to the square inch, may have been "father to the man" in the following true story:

Mr. Jenks, the hustling "super" of Rann & Co., was sitting at his desk with a pad and pencil, lost in figures and thought. Suddenly he threw down the pencil, pulled his straw hat more firmly onto his head, chewed his cigar savagely, spat on the floor, and nervously ejaculated:

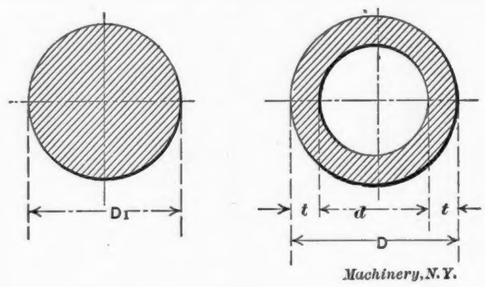
"Gee, that was a narrow escape!"

"What was a narrow escape?" said Rann, just then opening the door of Jenks' little office.

"Why, that hydraulic press you know is coming next week and we were going to put it on the third floor."

"Yes, what of that?"

TABLE OF FACTORS USED IN EQUATIONS FOR FINDING DIMENSIONS OF HOLLOW SHAFTS TO REPLACE SOLID SHAFTS



Expressions from Equations (2), (3) and (4)	Ratio k = d ÷ D									
	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
$\sqrt[3]{\frac{1}{1-k^4}}$	1.0216	1.0324	1.0473	1.0677	1.0959	1.1353	1.1920	1.2790	1.4273	1.7534
$k\sqrt[3]{\frac{1}{1-k^4}}$	0.5108	0.5678	0.6284	0.6940	0.7671	0.8514	0.9514	1.0871	1.2846	1.6658
$\frac{1-k}{2}\sqrt[3]{\frac{1}{1-k^4}}$	0.2574	0.2323	0.2095	0.1869	0.1644	0.1419	0.1192	0.0959	0.0714	0.0438
Weight of Hollow Shaft*..	78.3	74.35	70.2	65.8	61.3	56.4	51.6	45.4	38.7	29.9

* Weight of hollow shaft is given in per cent of weight of solid shaft.

"Well, I've just been figuring up the floor load and——"

"That floor will carry 200 pounds to the square foot safely and that two-ton press will stand in a space six by eight feet," said Rann. "I don't see what you're fooling away time on that for."

"Yes, I know what the floor will carry and the weight of the press all right, *but have you thought of the load when the press is in use?*" Jenks shot out triumphantly. "Why, man, this catalogue says that press can exert a pressure of fifty tons! Fifty tons—think of that! It would be just like some fool kid to pump it up to the limit some day and send us all crashing down into the cellar. I tell you, it ain't safe. We've got to put that press down in the basement on solid earth where nothing can give way. It's lucky I thought of that in time!"

* * *

ALUMINUM ALLOYS

The following aluminum alloys for making aluminum crank-case castings for small gasoline engines are recommended by *The Foundry:* 1. Copper, 5 pounds, aluminum, 95 pounds; 2. Copper, 2 pounds, zinc, 15 pounds, aluminum, 76 pounds; 3. Copper, 3 pounds, zinc, 25 pounds, aluminum, 72 pounds; 4. Scrap cast aluminum, 99 pounds, magnesium, 1 pound, zinc-chloride, 1 pound. In the last case the aluminum is first melted and the magnesium added. Then the chloride is thrown on the top and the mass is stirred gently and poured at a dull red heat. The various alloys are recommended in the order given.

EXTERNAL CUTTING TOOLS—4

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

This installment contains information on proportions for hollow mills of the solid type, and feeds and speeds for external cutting tools in general, such as box-tools, hollow mills and swing tools.

Hollow Mills

For roughing down work, especially brass work, a hollow mill is found to give very satisfactory results. Two hollow mills of the solid type are shown in Fig. 18. These hollow mills are ground for steel work, a rake being given to the cutting edge. This is found to give better results on steel work than having the cutting face of the blades parallel with the center line.

The proportions for hollow mills and the cutting angles for various materials are given in Table I. The sizes from 0.065 to 0.462 inch given in column *A* are worked out for roughing mills for the A. S. M. E. standard and special screw sizes, an allowance of from 0.005 to 0.015 inch being made for finishing. Of course, these mills can be made to cut smaller

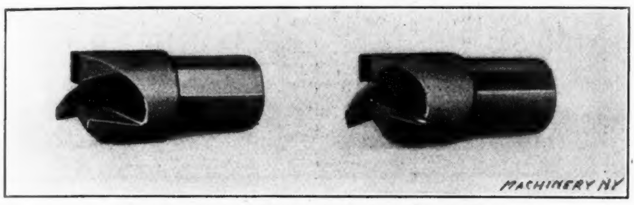


Fig. 18. Hollow Mills of the Solid-blade Type

by using a collar on them. In making these hollow mills, they should be reamed out tapering from the rear, so that the blades will clear and not drag on the work. A taper of from about 1/8 to 3/16 inch per foot is generally satisfactory. For steel work the cutting edge is set about 1/10 of the diameter ahead of the center, but for brass work it should be on the center line. These distances are given in column *F*. Hollow mills for cutting steel are, as a rule, made either from steel containing a very high percentage of carbon or high-speed steel. When high speeds are used, high-speed steel is preferable.

A hollow mill of the inserted-blade type is shown in Fig. 19. This is also the product of the Brown & Sharpe Mfg. Co.

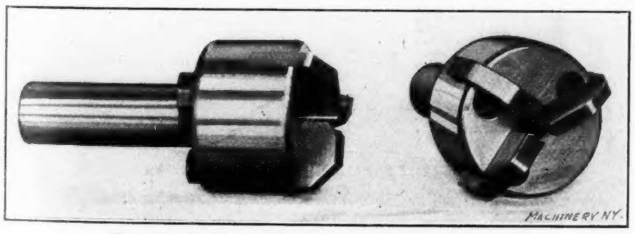


Fig. 19. Hollow Mill of the Inserted-blade Type

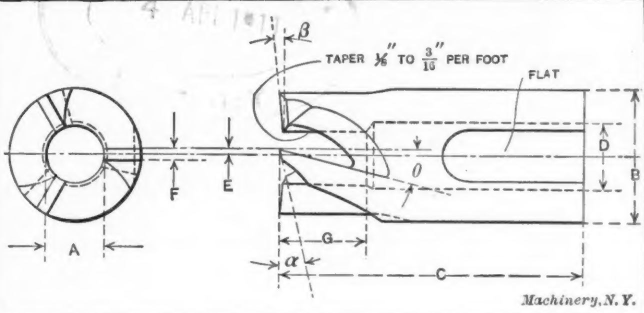
and is used extensively for screw machine work, its use being mainly for hand screw machines; but it is sometimes also applied to the automatics. This mill is provided with three cutting blades, which are held in the body of the holder by clamp-bolts fitting in the beveled slots cut in the blades. The clamp-bolts are held by means of nuts located at the rear of the body. The blades are sharpened by grinding on the ends, and can be adjusted for diameter by simply releasing the nuts, and moving the blades out or in by hand.

Hollow Mill Holders

When hollow mills of the solid type are used it is necessary to have a holder which can be set so that the mill will cut concentric. A holder which is used for this purpose, and which gives satisfactory results, is the standard floating holder made by the Brown & Sharpe Mfg. Co. This holder has been described in previous articles, so it will not be necessary to give a description of it here. In setting a hollow mill, the screws holding the floating part of the holder to the body

* Associate Editor of MACHINERY.

TABLE I. CUTTING ANGLES AND PROPORTIONS FOR HOLLOW MILLS



Cutting Angles for Hollow Mills

Angle	Brass Rod	Machine Steel	Tool Steel
α	8 degrees	15 degrees	10 degrees
β	8 degrees	5 degrees	3 degrees
θ	....	15 degrees	10 degrees

Proportions for Hollow Mills

A	B	C	D	E	F	G
0.065	1/2	1 1/4	1/4	0.007	0.020	1/4
0.078	1/2	1 1/4	1/4	0.008	0.020	1/4
0.091	1/2	1 1/4	1/4	0.009	0.025	1/4
0.105	1/2	1 1/4	1/4	0.011	0.025	1/4
0.120	1/2	1 1/4	1/4	0.012	0.025	1/4
0.135	1/2	1 1/4	1/4	0.014	0.030	1/4
0.148	1/2	1 1/4	1/4	0.015	0.030	1/4
0.161	1/2	1 1/4	1/4	0.016	0.035	5/16
0.174	1/2	1 1/4	1/4	0.017	0.035	5/16
0.187	1/2	1 1/4	1/4	0.019	0.040	5/16
0.200	5/8	1 1/2	3/8	0.020	0.040	5/16
0.226	5/8	1 1/2	3/8	0.023	0.045	5/16
0.252	5/8	1 1/2	3/8	0.025	0.045	5/16
0.280	5/8	1 1/2	3/8	0.028	0.050	3/8
0.305	5/8	1 1/2	3/8	0.031	0.060	3/8
0.332	5/8	1 1/2	3/8	0.033	0.065	3/8
0.358	5/8	1 1/2	3/8	0.036	0.070	7/16
0.385	1	2 1/4	3/4	0.039	0.075	7/16
0.410	1	2 1/4	3/4	0.041	0.080	7/16
0.436	1	2 1/4	3/4	0.044	0.085	1/2
0.462	1	2 1/4	3/4	0.046	0.090	1/2
0.480	1	2 1/4	3/4	0.048	0.095	5/8
0.515	1	2 1/4	3/4	0.052	0.100	5/8
0.578	1	2 1/4	3/4	0.058	0.105	3/4
0.640	1	2 1/4	3/4	0.064	0.110	3/4
0.703	1	2 1/4	13/16	0.070	0.115	7/8
0.765	1	2 1/4	13/16	0.077	0.120	7/8

proper are released and the mill is set concentric. It is desirable to turn a bevel on the end of the work to facilitate the setting of the hollow mill, as described in a previous article.

TABLE II. FEEDS FOR ROUGHING BOX-TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

1/32-inch Chip				1/8-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/16	0.0020	0.0015	0.0010	3/8	0.0045	0.0030	0.0020
1/8	0.0030	0.0020	0.0015	7/16	0.0050	0.0035	0.0025
3/16	0.0040	0.0030	0.0020	1/2	0.0060	0.0040	0.0030
1/4	0.0050	0.0040	0.0025	9/16	0.0070	0.0050	0.0035
5/16	0.0060	0.0045	0.0030	5/8	0.0085	0.0060	0.0040
3/8	0.0075	0.0050	0.0035	3/4	0.0100	0.0070	0.0050
1/16-inch Chip				3/16-inch Chip			
1/4	0.0045	0.0030	0.0020	1/2	0.0040	0.0025	0.0015
5/16	0.0060	0.0040	0.0025	9/16	0 0045	0.0030	0.0018
3/8	0.0090	0.0060	0 0030	5/8	0.0050	0.0032	0.0020
7/16	0.0105	0.0070	0.0040	11/16	0.0055	0.0035	0.0023
1/2	0.0120	0.0080	0.0050	3/4	0.0060	0 0040	0.0025
9/16	0.0135	0.0090	0.0060	13/16	0.0070	0.0045	0.0028
5/8	0.0150	0.0100	0.0075	7/8	0.0075	0.0050	0.0030

Speeds for External Cutting Tools

The following speeds are for external cutting tools such as box-tool cutters, hollow mills, etc., made from ordinary carbon and high-speed steel, but do not apply to circular cut-off or form tools.

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM ORDINARY CARBON STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	170 — 180
Gun screw iron	70 — 80
Norway iron and machine steel	60 — 70
Drill rod and tool steel	35 — 40

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM HIGH-SPEED STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	250 — 270
Gun screw iron	100 — 120
Norway iron and machine steel	90 — 100
Drill rod and tool steel	50 — 60

The speeds given for high-speed steel are for tools made from Novo superior or other similar steels. Where a high-carbon steel, such as Styrian steel, is used, a slightly decreased speed should be employed.

Feeds for Roughing and Finishing Box-tools

In Table II are given feeds for roughing box-tools in which the cutters are made from high-speed and carbon steel, and in Table III are given feeds for finishing box-tools in which the cutters are made from high-speed and carbon steel. These feeds will give satisfactory results where proper discretion is used. The feeds for roughing, of course, could in some cases be increased if conditions would permit; but as a rule the feeds given are sufficiently high.

TABLE III. FEEDS FOR FINISHING BOX-TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
0.005-inch Chip				0.020-inch Chip			
1/32	0.0020	0.0020	0.0018	3/8	0.0040	0.0040	0.0025
1/16	0.0030	0.0030	0.0020	7/16	0.0045	0.0045	0.0030
3/32	0.0045	0.0045	0.0025	1/2	0.0050	0.0050	0.0035
1/8	0.0060	0.0060	0.0030	9/16	0.0060	0.0060	0.0035
3/16	0.0070	0.0070	0.0040	5/8	0.0070	0.0070	0.0040
1/4	0.0080	0.0080	0.0050	11/16	0.0075	0.0075	0.0045
5/16	0.0100	0.0100	0.0060	3/4	0.0080	0.0080	0.0050
3/8	0.0120	0.0120	0.0080	13/16	0.0090	0.0090	0.0050
0.010-inch Chip				0.030-inch Chip			
1/4	0.0070	0.0070	0.0035	1/2	0.0040	0.0040	0.0020
5/16	0.0080	0.0080	0.0040	9/16	0.0045	0.0045	0.0022
3/8	0.0085	0.0085	0.0045	5/8	0.0050	0.0050	0.0025
7/16	0.0090	0.0090	0.0050	11/16	0.0055	0.0055	0.0028
1/2	0.0095	0.0095	0.0055	3/4	0.0060	0.0060	0.0030
9/16	0.0100	0.0100	0.0060	13/16	0.0070	0.0070	0.0035
5/8	0.0100	0.0100	0.0065	7/8	0.0080	0.0080	0.0040

Feeds for Turning with Swing Tools

Owing to the fact that swing tools are not so rigidly constructed as the ordinary box-tools, it has been found advisable to decrease the feeds slightly below those used for box-tools. Feeds which have been found satisfactory for straight turning with swing tools are given in Table IV. These feeds are about 30 per cent less than those used for box-tools.

Feeds for Taper Turning

For taper or irregular turning with swing tools, the greatest depth of the chip should be considered, and the same feed used as that given in Table IV. For taper turning with the Brown & Sharpe standard taper turning tools, the greatest depth should be considered, and the same feed used as given in Tables II and III for roughing and finishing cuts, respectively. Where the taper is greater than ¼ inch per foot, it is advisable to use two taper turning tools, one for roughing, and the other for finishing.

Feeds for Hollow Mills

In Table V are given feeds for hollow mills which are made from ordinary carbon or high-speed steel. These feeds apply both to hollow mills of the solid and inserted-blade types, and are for taking a chip of from 1/16 inch to 1/4 inch deep. The feeds given are not excessively high, and in some cases could be increased, especially when the work is not exceedingly long, and where the tool would not be on the work for a considerable time.

TABLE IV. FEEDS FOR TURNING WITH SWING TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/32-inch Chip				1/8-inch Chip			
1/16	0.0010	0.0008	0.0005	3/8	0.0020	0.0015	0.0010
1/8	0.0015	0.0010	0.0008	7/16	0.0025	0.0018	0.0015
3/16	0.0020	0.0015	0.0010	1/2	0.0030	0.0020	0.0018
1/4	0.0030	0.0020	0.0015	9/16	0.0035	0.0025	0.0020
5/16	0.0035	0.0025	0.0018	5/8	0.0038	0.0028	0.0022
3/8	0.0040	0.0030	0.0020	11/16	0.0042	0.0030	0.0025
1/16-inch Chip				3/16-inch Chip			
1/4	0.0025	0.0020	0.0010	1/2	0.0020	0.0010	0.0008
5/16	0.0030	0.0022	0.0013	9/16	0.0025	0.0013	0.0010
3/8	0.0035	0.0025	0.0015	5/8	0.0028	0.0015	0.0012
7/16	0.0040	0.0028	0.0018	11/16	0.0030	0.0018	0.0015
1/2	0.0045	0.0030	0.0020	3/4	0.0035	0.0020	0.0018
9/16	0.0050	0.0032	0.0025	13/16	0.0038	0.0022	0.0020
5/8	0.0060	0.0035	0.0028	7/8	0.0040	0.0025	0.0020

TABLE V. FEEDS FOR HOLLOW MILLS MADE FROM HIGH-SPEED AND CARBON STEEL

Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/16-inch Chip				3/16-inch Chip			
3/16	0.0045	0.0030	0.0015	1/2	0.0060	0.0045	0.0020
1/4	0.0050	0.0040	0.0018	9/16	0.0065	0.0050	0.0023
5/16	0.0055	0.0045	0.0020	5/8	0.0070	0.0055	0.0025
3/8	0.0060	0.0050	0.0025	11/16	0.0080	0.0060	0.0030
7/16	0.0070	0.0050	0.0028	3/4	0.0090	0.0065	0.0035
1/2	0.0080	0.0060	0.0030	13/16	0.0100	0.0070	0.0040
1/8-inch Chip				1/4-inch Chip			
3/8	0.0070	0.0050	0.0030	5/8	0.0050	0.0035	0.0015
7/16	0.0075	0.0055	0.0035	11/16	0.0055	0.0040	0.0018
1/2	0.0080	0.0060	0.0040	3/4	0.0060	0.0050	0.0020
9/16	0.0090	0.0065	0.0050	13/16	0.0070	0.0055	0.0025
5/8	0.0110	0.0075	0.0060	7/8	0.0080	0.0060	0.0030
11/16	0.0130	0.0090	0.0070	..	......	......	......
3/4	0.0150	0.0110	0.0080	..	......	......	......

* * *

Builders of machine tools are often requested to build special machinery to suit the peculiar needs of manufacturers, and most concerns do more or less designing and building of machinery out of their regular line. They are practically unanimous in the opinion that it does not pay, and more reluctance is manifested to engaging in any work that interferes with the routine of manufacturing than in the past. In the first place, the maker can hardly ever get a price that yields a reasonable profit on the actual work and pays for the designing. In the second place, the inventive genius of the concern is more profitably employed in designing jigs, fixtures and special machines for reducing the cost and facilitating the output of the plant.

MAKING A KNIFE-EDGE SQUARE

By C. H. WILCOX*

The easiest way to make a knife-edge square is to get an ordinary hardened square and remove the blade (which is soldered in place), grind it to a knife-edge on both sides, lap it true, then resolder the blade in the stock. The making of a knife-edge square by the method to be described requires a precision test-block, a lapping block, a true surface-plate, and a grinding arbor.

The precision block may be made from a piece of round steel by grinding and lapping it perfectly cylindrical and squaring the ends. The block is first bored for an arbor, as illustrated in Fig. 1, and the ends are counterbored to provide a clearance space for the emery wheel when grinding them square. The block is hardened and then placed on the arbor for grinding, the machine having been previously set by a test piece to grind as nearly cylindrical as possible. When the outside is ground to the same diameter at all points, the ends should be finished without disturbing the setting of the work. The work is then removed from the arbor and the ends made perfectly flat by lapping.

The lapping block used in finishing the beveled edges of the square blade, should be of cast iron and have a true plane

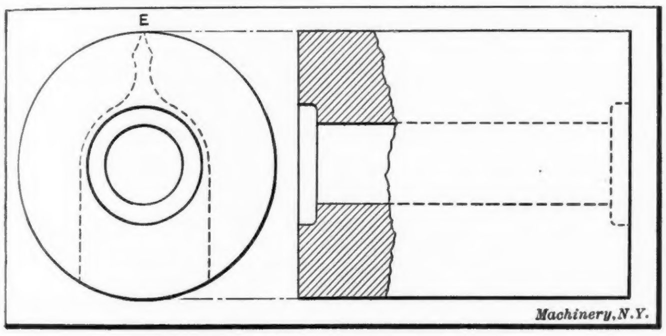


Fig. 1. Cylindrical Test Block for Squares

surface. This block should also have grooves cut into its surface as illustrated in Fig. 2. These grooves are 1 inch apart, about 1/16 inch wide, 1/16 inch deep, and at an angle of 45 degrees, as shown. They are important in that they allow the surplus emery to fall out of the way.

The first operation on the square blade is that of beveling the edges, which is done in a cylindrical grinder, as illustrated in the end view, Fig. 3. An arbor is first made, having a central milled slot long enough and of sufficient width to accommodate the square blade. A small hole should also be drilled in one end for the piece of drill rod *R*, which is supported by the table and locates the work in the correct angular position. The blade should be set central in this slot

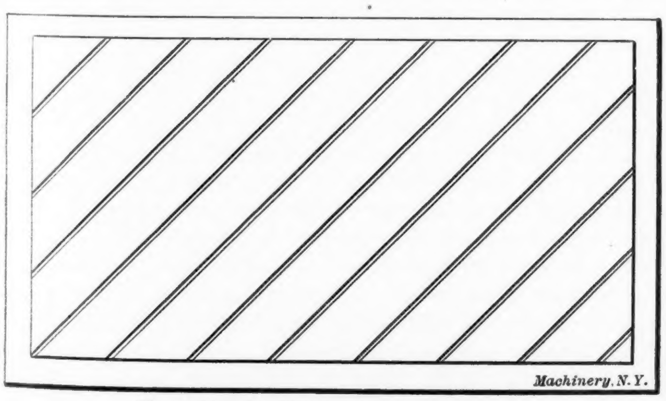
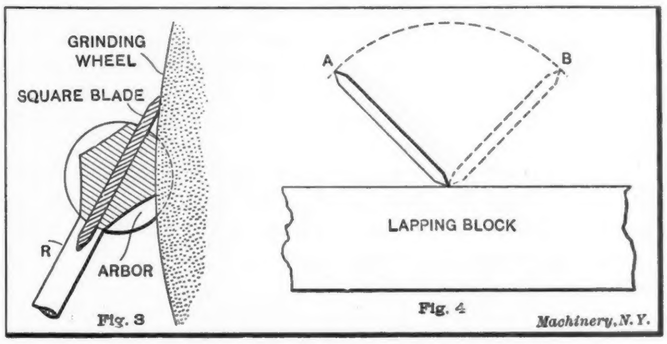


Fig. 2. Lapping Plate with Grooved Surface

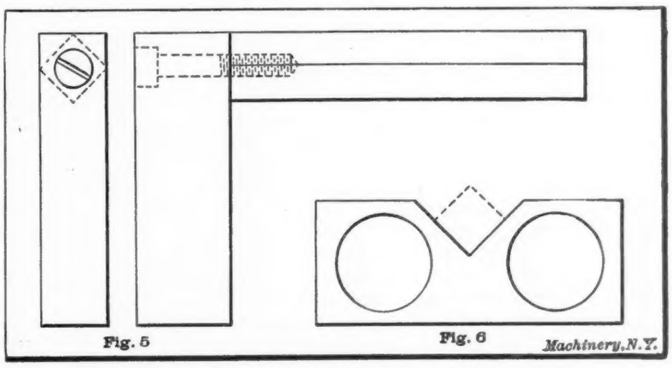
and then fastened by applying solder at the ends. Prior to beveling, the blade edges are ground round by revolving the arbor and blade between the grinding centers, which should previously be set for parallel grinding by the use of a test arbor. After this operation, the edges are beveled as indicated in Fig. 3. When one side has been beveled to nearly the center of the blade, the arbor is reversed on the centers, which brings the other side next to the wheel. The grinding is then continued until a knife-edge having a width of about 1/64 inch is obtained. Care should be taken to have this edge central by feeding the wheel in to the same position when grinding each side. By turning the arbor one-half a revolution, and changing the position of rod *R*, the opposite edge may be finished in a similar manner. The blade is then removed and both edges are lapped, which is an operation requiring great care and patience.

After charging the lapping block with flour emery, or carborundum, the edge of the blade is lapped by moving it side-



Figs. 3 and 4. Beveling Edges of Blade and Lapping

wise across the block. It should be held between the thumb and fore-finger, and, in addition to the cross-wise movement, there should be a gradual rotary movement through an angle of about 90 degrees, as indicated by the full and dotted lines in Fig. 4. Care should also be taken to use different parts of the lapping block surface, in order to distribute the wear and prevent the block from being worn inaccurate. The blade while being lapped in this manner should be tested at intervals by holding it in contact with a test bar. When making this test, the blade should be turned on its edge, as when lapping, to see if it shuts out the light when held in different angular positions. The lapping process should be continued



Figs. 5 and 6. Special Knife-edge Square and Lapping Block

until all light is excluded between the test piece and blade for any position of the latter between points *A* and *B*, Fig. 4. The stock should then be lapped.

A glass bar is the best for testing purposes, as it does not change in shape under different atmospheric conditions as does steel, but in case such a bar is not available, one may be made by lapping one edge of a bar of steel as nearly flat and true as possible. After the steel has been machined to shape, it should be allowed to "season" for at least six months before lapping it; during this time a slight change in shape will doubtless occur, which would destroy the accuracy of the bar if it were lapped without having a seasoning period in which to assume a more or less permanent shape.

After the blade is finished, that part which is attached to the beam should be carefully tinned and all surplus solder wiped off with a piece of waste. The blade is then set in the beam and positioned by using the precision test block. The outside edge may be tested by placing the square and test block on an accurate surface-plate and bringing the two into contact. The blade should be located with sufficient accuracy to exclude the light. When it is correctly set, it is fastened by placing a little soldering acid in the joint and heating it very carefully until the solder is melted. The square

* Address: 37 Parkwood St., Springfield, Mass.

Speeds for External Cutting Tools

The following speeds are for external cutting tools such as box-tool cutters, hollow mills, etc., made from ordinary carbon and high-speed steel, but do not apply to circular cut-off or form tools.

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM ORDINARY CARBON STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	170 — 180
Gun screw iron	70 — 80
Norway iron and machine steel	60 — 70
Drill rod and tool steel	35 — 40

SPEEDS FOR BOX-TOOL CUTTERS AND HOLLOW MILLS MADE FROM HIGH-SPEED STEEL

Material	Surface Speed in Feet per Minute
Brass (ordinary quality)	250 — 270
Gun screw iron	100 — 120
Norway iron and machine steel	90 — 100
Drill rod and tool steel	50 — 60

The speeds given for high-speed steel are for tools made from Novo superior or other similar steels. Where a high-carbon steel, such as Styrian steel, is used, a slightly decreased speed should be employed.

Feeds for Roughing and Finishing Box-tools

In Table II are given feeds for roughing box-tools in which the cutters are made from high-speed and carbon steel, and in Table III are given feeds for finishing box-tools in which the cutters are made from high-speed and carbon steel. These feeds will give satisfactory results where proper discretion is used. The feeds for roughing, of course, could in some cases be increased if conditions would permit; but as a rule the feeds given are sufficiently high.

TABLE III. FEEDS FOR FINISHING BOX-TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

0.005-inch Chip				0.020-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/32	0.0020	0.0020	0.0018	3/8	0.0040	0.0040	0.0025
1/16	0.0030	0.0030	0.0020	7/16	0.0045	0.0045	0.0030
3/32	0.0045	0.0045	0.0025	1/2	0.0050	0.0050	0.0035
1/8	0.0060	0.0060	0.0030	9/16	0.0060	0.0060	0.0035
3/16	0.0070	0.0070	0.0040	5/8	0.0070	0.0070	0.0040
1/4	0.0080	0.0080	0.0050	11/16	0.0075	0.0075	0.0045
5/16	0.0100	0.0100	0.0060	3/4	0.0080	0.0080	0.0050
3/8	0.0120	0.0120	0.0080	13/16	0.0090	0.0090	0.0050
0.010-inch Chip				**0.030-inch Chip**			
1/4	0.0070	0.0070	0.0035	1/2	0.0040	0.0040	0.0020
5/16	0.0080	0.0080	0.0040	9/16	0.0045	0.0045	0.0022
3/8	0.0085	0.0085	0.0045	5/8	0.0050	0.0050	0.0025
7/16	0.0090	0.0090	0.0050	11/16	0.0055	0.0055	0.0028
1/2	0.0095	0.0095	0.0055	3/4	0.0060	0.0060	0.0030
9/16	0.0100	0.0100	0.0060	13/16	0.0070	0.0070	0.0035
5/8	0.0100	0.0100	0.0065	7/8	0.0080	0.0080	0.0040

Feeds for Turning with Swing Tools

Owing to the fact that swing tools are not so rigidly constructed as the ordinary box-tools, it has been found advisable to decrease the feeds slightly below those used for box-tools. Feeds which have been found satisfactory for straight turning with swing tools are given in Table IV. These feeds are about 30 per cent less than those used for box-tools.

Feeds for Taper Turning

For taper or irregular turning with swing tools, the greatest depth of the chip should be considered, and the same feed used as that given in Table IV. For taper turning with the Brown & Sharpe standard taper turning tools, the greatest depth should be considered, and the same feed used as given in Tables II and III for roughing and finishing cuts, respectively. Where the taper is greater than 1/4 inch per foot, it is advisable to use two taper turning tools, one for roughing, and the other for finishing.

Feeds for Hollow Mills

In Table V are given feeds for hollow mills which are made from ordinary carbon or high-speed steel. These feeds apply both to hollow mills of the solid and inserted-blade types, and are for taking a chip of from 1/16 inch to 1/4 inch deep. The feeds given are not excessively high, and in some cases could be increased, especially when the work is not exceedingly long, and where the tool would not be on the work for a considerable time.

TABLE IV. FEEDS FOR TURNING WITH SWING TOOLS—CUTTERS MADE FROM HIGH-SPEED AND CARBON STEEL

1/32-inch Chip				1/8-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
1/16	0.0010	0.0008	0.0005	3/8	0.0020	0.0015	0.0010
1/8	0.0015	0.0010	0.0008	7/16	0.0025	0.0018	0.0015
3/16	0.0020	0.0015	0.0010	1/2	0.0030	0.0020	0.0018
1/4	0.0030	0.0020	0.0015	9/16	0.0035	0.0025	0.0020
5/16	0.0035	0.0025	0.0018	5/8	0.0038	0.0028	0.0022
3/8	0.0040	0.0030	0.0020	11/16	0.0042	0.0030	0.0025
1/16-inch Chip				**3/16-inch Chip**			
1/4	0.0025	0.0020	0.0010	1/2	0.0020	0.0010	0.0008
5/16	0.0030	0.0022	0.0013	9/16	0.0025	0.0013	0.0010
3/8	0.0035	0.0025	0.0015	5/8	0.0028	0.0015	0.0012
7/16	0.0040	0.0028	0.0018	11/16	0.0030	0.0018	0.0015
1/2	0.0045	0.0030	0.0020	3/4	0.0035	0.0020	0.0018
9/16	0.0050	0.0032	0.0025	13/16	0.0038	0.0022	0.0020
5/8	0.0060	0.0035	0.0028	7/8	0.0040	0.0025	0.0020

TABLE V. FEEDS FOR HOLLOW MILLS MADE FROM HIGH-SPEED AND CARBON STEEL

1/16-inch Chip				3/16-inch Chip			
Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution	Smallest Diameter of Stock	Brass Rod, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
3/16	0.0045	0.0030	0.0015	1/2	0.0060	0.0045	0.0020
1/4	0.0050	0.0040	0.0018	9/16	0.0065	0.0050	0.0023
5/16	0.0055	0.0045	0.0020	5/8	0.0070	0.0055	0.0025
3/8	0.0060	0.0050	0.0025	11/16	0.0080	0.0060	0.0030
7/16	0.0070	0.0050	0.0028	3/4	0.0090	0.0065	0.0035
1/2	0.0080	0.0060	0.0030	13/16	0.0100	0.0070	0.0040
1/8-inch Chip				**1/4-inch Chip**			
3/8	0.0070	0.0050	0.0030	5/8	0.0050	0.0035	0.0015
7/16	0.0075	0.0055	0.0035	11/16	0.0055	0.0040	0.0018
1/2	0.0080	0.0060	0.0040	3/4	0.0060	0.0050	0.0020
9/16	0.0090	0.0065	0.0050	13/16	0.0070	0.0055	0.0025
5/8	0.0110	0.0075	0.0060	7/8	0.0080	0.0060	0.0030
11/16	0.0130	0.0090	0.0070	..	......	......	......
3/4	0.0150	0.0110	0.0080	..	......	......	......

* * *

Builders of machine tools are often requested to build special machinery to suit the peculiar needs of manufacturers, and most concerns do more or less designing and building of machinery out of their regular line. They are practically unanimous in the opinion that it does not pay, and more reluctance is manifested to engaging in any work that interferes with the routine of manufacturing than in the past. In the first place, the maker can hardly ever get a price that yields a reasonable profit on the actual work and pays for the designing. In the second place, the inventive genius of the concern is more profitably employed in designing jigs, fixtures and special machines for reducing the cost and facilitating the output of the plant.

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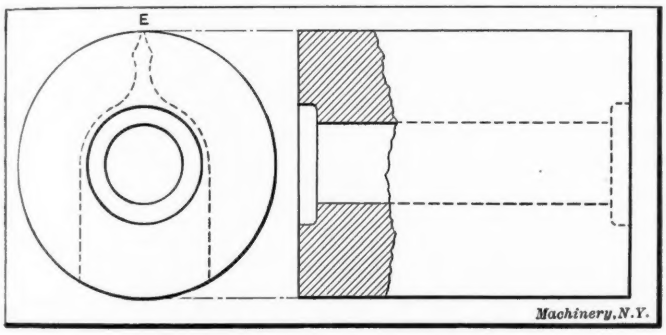

Fig. 1. Cylindrical Test Block for Squares

surface. This block should also have grooves cut into its surface as illustrated in Fig. 2. These grooves are 1 inch apart, about 1/16 inch wide, 1/16 inch deep, and at an angle of 45 degrees, as shown. They are important in that they allow the surplus emery to fall out of the way.

The first operation on the square blade is that of beveling the edges, which is done in a cylindrical grinder, as illustrated in the end view, Fig. 3. An arbor is first made, having a central milled slot long enough and of sufficient width to accommodate the square blade. A small hole should also be drilled in one end for the piece of drill rod *R*, which is supported by the table and locates the work in the correct angular position. The blade should be set central in this slot

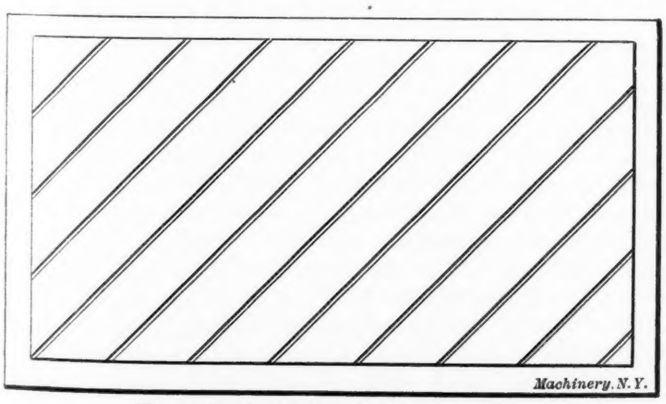

Fig. 2. Lapping Plate with Grooved Surface

and then fastened by applying solder at the ends. Prior to beveling, the blade edges are ground round by revolving the arbor and blade between the grinding centers, which should previously be set for parallel grinding by the use of a test arbor. After this operation, the edges are beveled as indicated in Fig. 3. When one side has been beveled to nearly the center of the blade, the arbor is reversed on the centers, which brings the other side next to the wheel. The grinding is then continued until a knife-edge having a width of about 1/64 inch is obtained. Care should be taken to have this edge central by feeding the wheel in to the same position when grinding each side. By turning the arbor one-half a revolution, and changing the position of rod *R*, the opposite edge may be finished in a similar manner. The blade is then removed and both edges are lapped, which is an operation requiring great care and patience.

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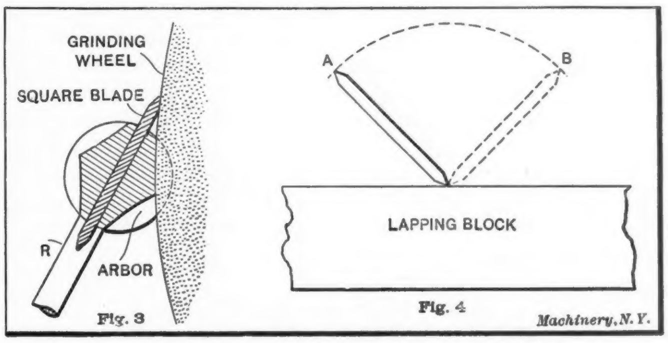
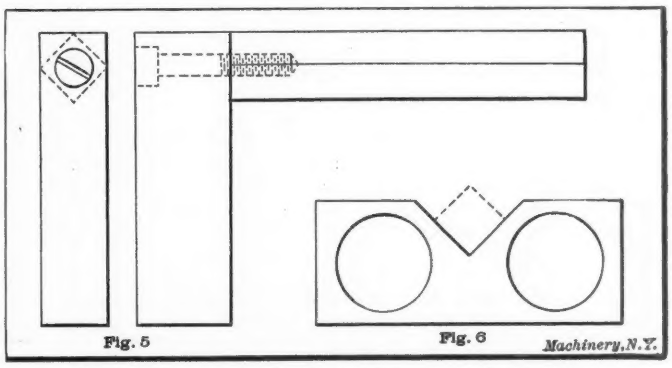


Figs. 3 and 4. Beveling Edges of Blade and Lapping

wise across the block. It should be held between the thumb and fore-finger, and, in addition to the cross-wise movement, there should be a gradual rotary movement through an angle of about 90 degrees, as indicated by the full and dotted lines in Fig. 4. Care should also be taken to use different parts of the lapping block surface, in order to distribute the wear and prevent the block from being worn inaccurate. The blade while being lapped in this manner should be tested at intervals by holding it in contact with a test bar. When making this test, the blade should be turned on its edge, as when lapping, to see if it shuts out the light when held in different angular positions. The lapping process should be continued



Figs. 5 and 6. Special Knife-edge Square and Lapping Block

until all light is excluded between the test piece and blade for any position of the latter between points *A* and *B*, Fig. 4. The stock should then be lapped.

A glass bar is the best for testing purposes, as it does not change in shape under different atmospheric conditions as does steel, but in case such a bar is not available, one may be made by lapping one edge of a bar of steel as nearly flat and true as possible. After the steel has been machined to shape, it should be allowed to "season" for at least six months before lapping it; during this time a slight change in shape will doubtless occur, which would destroy the accuracy of the bar if it were lapped without having a seasoning period in which to assume a more or less permanent shape.

After the blade is finished, that part which is attached to the beam should be carefully tinned and all surplus solder wiped off with a piece of waste. The blade is then set in the beam and positioned by using the precision test block. The outside edge may be tested by placing the square and test block on an accurate surface-plate and bringing the two into contact. The blade should be located with sufficient accuracy to exclude the light. When it is correctly set, it is fastened by placing a little soldering acid in the joint and heating it very carefully until the solder is melted. The square

* Address: 37 Parkwood St., Springfield, Mass.

is then removed and allowed to cool. If it is carefully handled during this operation, the blade and square will doubtless remain in the correct relation with each other, though it may be necessary to make several trials before obtaining satisfactory results.

In Fig. 5 a special type of knife-edge square is shown, the blade of which is ground square and held to the stock by a screw. It is essential that the inner end of this blade be lapped perfectly square, and when performing this operation a block such as shown in Fig. 6, should be used. This block has a 90-degree V-groove cut into one side parallel with the bottom. There are also two holes through the block to lighten it. When in use, the blade is placed in the V-groove, as indicated by the dotted lines, and the block and blade are moved back and forth on the lapping plate until the work, thus held in a right-angle position, is finished square on the end. This block is also useful for miscellaneous lapping operations.

A combination precision test block, straightedge and knife-edge square may be made by forming the block, Fig. 1, as shown by the dotted lines in the end view, the edge *E* being ground and lapped to a knife-edge.

* * *

TO PREVENT DUSTING OF CONCRETE FLOORS

The *Engineering News* gives the following receipt to prevent dusting of concrete floors already laid as one recommended by Mr. Albert Moyer, associate member of the American Society of Civil Engineers:

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush, removing all dirt and loose particles. Allow the surface to dry. As soon as dry apply a solution of one part water-glass (sodium silicate), and three to four parts of water, the proportion of water depending upon the porosity of the concrete. The denser the concrete, the weaker the solution required. Stir well, and apply this mixture with a brush (a large whitewash brush with long handle will be found to be the most economical). Do not mix a greater quantity than can be used in an hour. If this solution is sufficiently thin, it will penetrate the pores of the concrete. Allow the concrete surface thus treated to dry. As soon as dry, wash off with clean water, using a mop. Again allow the surface to dry and apply the solution as before. Allow to dry and again wash off with clean water, using a mop. As soon as the surface is again dry, apply the solution as before. If the third coat does not flush to the surface, apply another coat as above. The sodium silicate, which remains on the surface, not having come in contact with the other alkalies in the concrete, is readily soluble in water and can therefore be easily washed off, thus evening up the color and texture of the floor. That which has penetrated into the pores, having come in contact with the other alkalies in the concrete, has formed into an insoluble and very hard material, hardening the surface, preventing dusting and adding materially to the wearing value of the floor.

* * *

The time required for one rotation of the earth on its axis is arbitrarily divided into 24 hours. The hour is subdivided into 60 minutes and the minute into 60 seconds. To most of us a watch or clock is simply a mechanism for recording the flight of the hours, minutes and seconds—we think of it as a means for moving indicating hands synchronously with the turning of the earth, which, of course, it is. To begin at the other end of the time scale and conceive that a watch or any other escapement timepiece is simply a counting machine for counting seconds or fractions of seconds seems rather strange, but the conception is right. An ordinary American watch beats 18,000 times an hour, or exactly five times a second, if accurate. It counts every one-fifth second with unfailing regularity and precision night and day and registers the count in the larger units of seconds, minutes and hours. What else is that but a counting machine?

DRAWING A COLD-ROLLED STEEL SHELL

By A. C. R.

In the "How and Why" columns of the February number of MACHINERY, there was an inquiry by C. H. R. for information regarding the drawing of a cold-rolled steel shell. The following sizes of dies for the various drawing operations will be found suitable for making this shell:

Diameter of first drawing die = 9 1/8 inches,
Diameter of second drawing die = 7 1/2 inches,
Diameter of third drawing die = 6 1/8 inches,
Diameter of fourth drawing die = 5 inches,
Diameter of fifth drawing die for reducing shoulder = 4 inches,
Diameter of sixth drawing die for reducing shoulder = 3 1/4 inches,
Diameter of seventh drawing die for reducing shoulder = 2 9/16 inches,
Finished drawing die for shoulder = 2 1/2 inches.

All these drawing dies are of the same type as those used in a double-action drawing press. The dies are made from cast iron with hardened steel drawing surfaces, and the shell is shoved through and not returned, to avoid scratching, except in the operations for reducing the shoulder or lower part of the shell where it is necessary to remove the shell by the knock-out. In the drawing operations previous to reducing the shoulder, the shell is stripped from the punch by projection *F* on the die (see Fig. 2).

The first drawing die is shown in Fig. 1, where *A* is the cast-iron base, *B* the tool-steel face, *C* the punch, and *D* the double-action blank holder which has a steel face. The punch is provided with a vent hole, as is the case with all the other

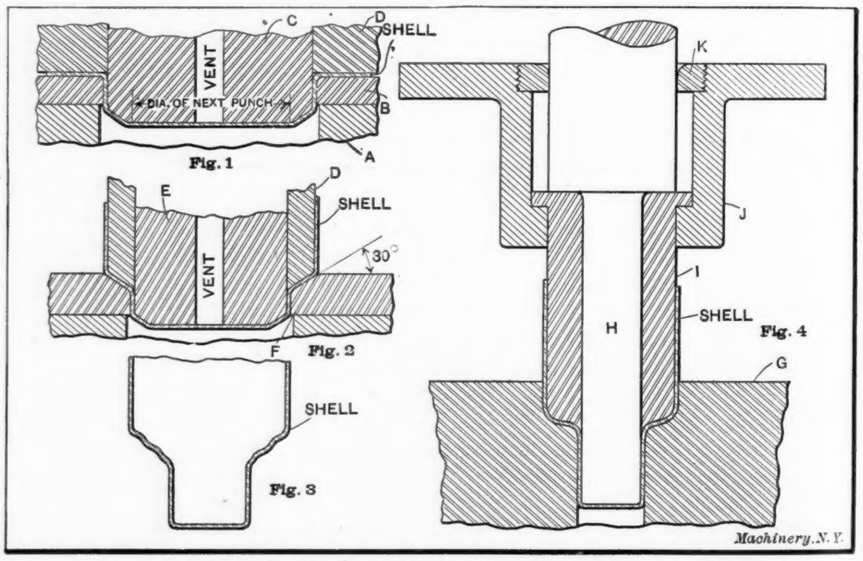


Fig. 1. First Drawing Die. Fig. 2. Re-drawing Die. Fig. 3. Shape of the Shell after reducing the Shoulder. Fig. 4. Punch and Die for Finish Drawing the Shell

drawing punches. The correct shape of the punch is shown in the illustration. In Fig. 2 the re-drawing die is shown. This die is of the same construction as that shown in Fig. 1, except that it is provided with a drawing angle of 30 degrees, which facilitates the drawing or "flowing" of the metal. The shell, in this case, is held by a blank holder *D*, which is actuated by the double-action of the press, and holds the blank with sufficient pressure to prevent it from buckling when being drawn out by the punch *E*. The dies for the successive re-drawing operations up to the point where the shoulder is reduced, are of similar construction to that shown in Fig. 2. The re-drawing dies for the reducing of the shoulder are also somewhat similar in design to that shown in Fig. 2, except that the shell is not forced through the die, but is returned by the knock-out bar of the press.

The punch and die for finish drawing and "ironing" out ridges in the shell is shown in Fig. 4. The die *G* is made of tool steel, as is also the punch *H* and the double-action blank holder *I*. The blank holder *I* is held in a bolster *J*, which, in turn, is fastened to the ram of the press. A collar *K* is screwed into the top of the bolster to stop the upward stroke of the blank holder until the shoulder on the punch comes in

contact with it. The idea of using a double-action press and a die along the lines shown in Fig. 4 is to throw the blow on the punch and crankshaft of the press, instead of on the toggles. This also insures the stripping of the shell from the punch, as the small end of the shell, which is brought down to size, is likely to stick in the die in this operation. Having a die of this construction also facilitates the stripping of the shell from the blank holder. The shape of the shell up to and beyond the shoulder is indicated in Fig. 3 where slight ridges are shown at the shoulder. These ridges are caused by the successive re-drawing operations.

The writer would call the reader's attention to the gradual decrease in the metal after each successive drawing operation. It is evident, of course, that the diameter of the shell must become less as it is reduced, so that the metal will not be subjected to excessive strain. The second drawing operation, that is, the first operation after the cup has been formed, reduces the shell from $9\frac{1}{8}$ inches to $7\frac{1}{2}$ inches or $1\frac{5}{8}$ inch in diameter. For the following drawing operations, the reductions are as follows:

Third drawing operation reduces the shell from $7\frac{1}{2}$ to $6\frac{1}{8}$ inches or $1\frac{3}{8}$ inch in diameter,

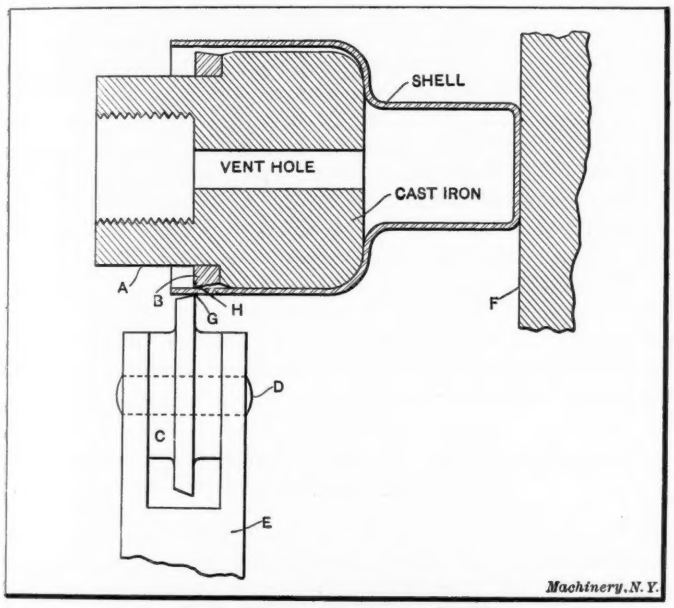


Fig. 5. Trimming the Shell to Length

Fourth drawing operation reduces the shell from $6\frac{1}{8}$ inches to 5 inches or $1\frac{1}{8}$ inch in diameter,

Fifth drawing operation reduces the shell from 5 inches to 4 inches or 1 inch in diameter.

These are the reductions in size of the upper part of the shell. The reductions in the re-drawing operations for the lower part of the shell are still less than those for the upper part, as follows:

For the first drawing of shoulder the shell is reduced from 4 to $3\frac{1}{4}$ inches or $\frac{3}{4}$ inch in diameter,

For the second drawing operation of shoulder, the shell is reduced from 3 1/4 to 2 9/16 inches, or 11/16 inch in diameter,

For the third drawing operation of shoulder, the shell is reduced from 2 9/16 to 2 1/2 inches, or 1/16 in diameter.

It is absolutely necessary that all the drawing punches have vent holes in them, so that the shell, when drawn, will not stick to the punch or die and work havoc with the press. Another point which should be carefully considered is the diameter of the blank. The blank should be made of such a size, that when the cup is finish drawn there will be from $\frac{3}{8}$ to $\frac{1}{2}$ inch to trim off. The reason for this is that the upper or open end of the shell becomes hard and crystallized owing to the excessive drawing, and extremely brittle. The crystallized part of the shell should be entirely removed so that, in flanging, the shell will not split or crack at the top edges. The writer would suggest that the shell, during the drawing operations, should pass through several annealing and pickling operations, so as to make it more ductile.

After the shell has been drawn to the correct length, it is ready to be trimmed. This is done before the flanging and is usually accomplished in a lathe of the roller-spindle variety. A method which could be used in trimming this shell is shown in Fig. 5. The shell is placed on a cast-iron chuck *A* which is screwed to the nose of the spindle. This cast-iron chuck is made slightly smaller in diameter than the inside of the shell. A hardened steel ring *B* is driven on the cast-iron chuck, and acts as a cutting edge. The shell is cut off by means of a hardened roller *C*, which is made circular in shape but has no cutting teeth. It is held on a pin *D* which is driven into a holder *E*. This holder is held in the toolpost of the

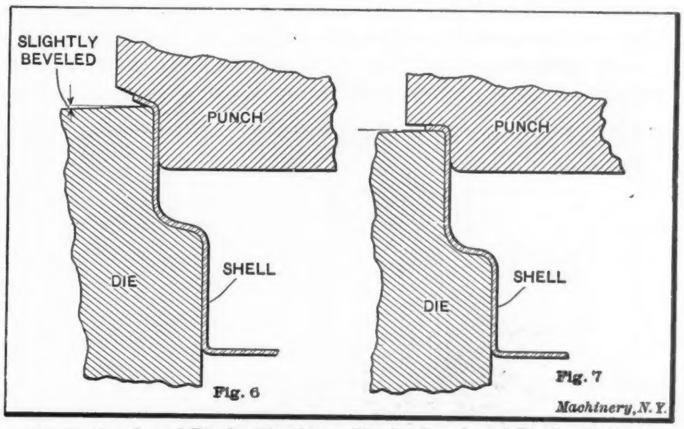


Fig. 6. Punch and Die for Starting the Flange Fig. 7. Punch and Die for Finishing the Flange

lathe. The shell is held on the chuck by means of a revolving backplate *F* which, in turn, is held in a holder fitted to the tailstock of the lathe. The edges *G* and *H* of the roller and hardened ring, respectively, are set so that they will slide freely past each other. The shank of the chuck is made considerably smaller than the shell, so that the part cut off can be easily removed.

The flanging of the top of the shell is the next operation. This can be done in two ways, one of which is shown in Figs. 6 and 7. This method requires two punches, both of which have hardened steel faces, but the same die can be used for both operations. The first punch, as shown in Fig. 6, starts the flange, and the second punch, as shown in Fig. 7,

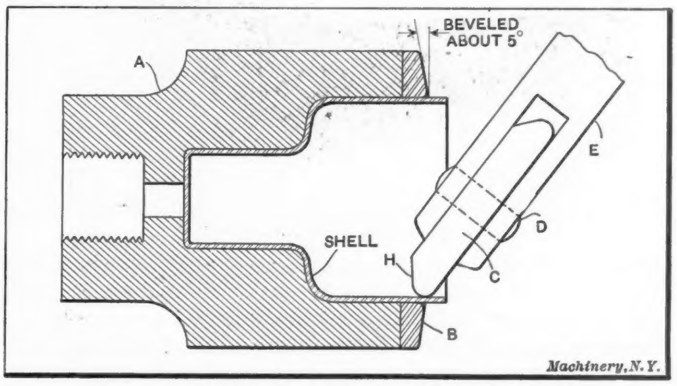


Fig. 8. Another Method of Flanging the Top of the Shell

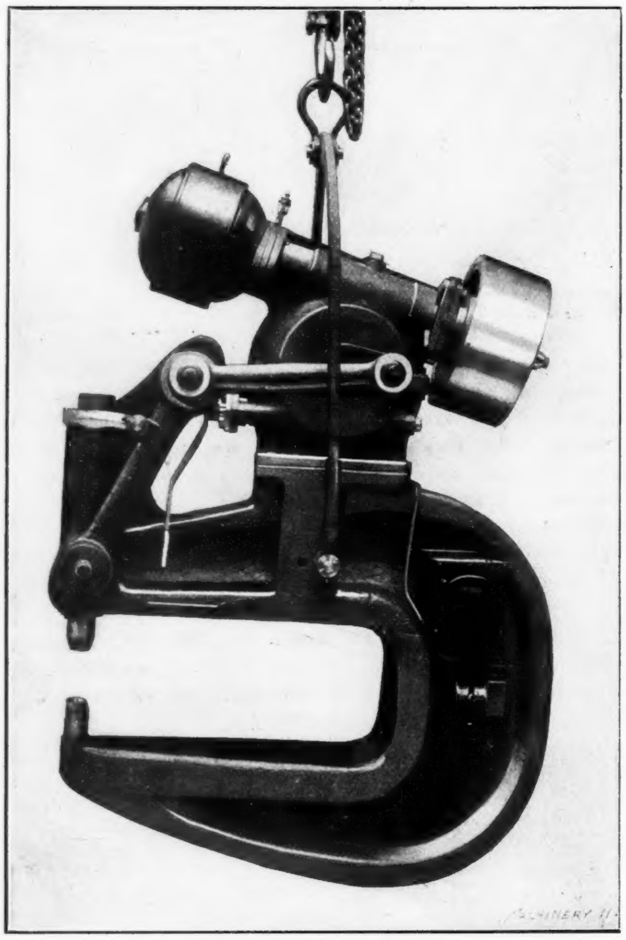
flattens it. The top face of the die is made of hardened steel, and is beveled slightly to allow for the spring in the material. The other method of forming the flange is shown in Fig. 8. This the writer considers better and more satisfactory than the one shown in Figs. 6 and 7. The flanging is accomplished in the lathe, the shell being held in a cast-iron chuck *A* which is screwed to the nose of the spindle. A tool-steel face *B* is fastened to the cast-iron chuck, over which the flange is bent by means of the hardened roller *C*. This roller is held on a pin *D* which is driven into a holder *E*, the latter being held in the toolpost of the lathe. The roller is applied in the manner shown in the illustration, and is brought from the inside out along the face. The face of the tool-steel ring *B* is beveled at about 5 degrees, to allow for the spring of the metal. Care should be taken to turn the flange over evenly and without buckling. The roller should be held at the correct angle to the work, to give the best results. When the flange is turned over, it is flattened down by the flat face *H* on the roller. If the suggestions given are carefully followed no difficulty should be encountered in making this shell.

GERMAN ELECTRIC RIVETING MACHINE

By FRANK C. PERKINS*

A German electric riveting machine, equipped with friction clutches as illustrated in the accompanying illustration, has been developed at Leipzig-Sellershausen. This machine for rivets of 1¼-inch diameter has a gap jaw of 40 inches, and is constructed for horizontal and vertical suspension. Another design has a novel form of electro-magnetic clutch for boiler riveting, while a third type has been designed with a friction clutch, to rivet all sorts of ironwork including rails and objects that do not require steam-tight rivets.

For locomotive and boiler work, use is made of an electric riveter having an electro-magnetic clutch so arranged that the



German Electric Riveting Machine

pressure stays on the rivet as long as desired. A machine of this construction for rivets of 1¼-inch diameter has a gap of jaw of 40 inches and is designed for universal suspension. A machine has also been built for rivets of 1-inch diameter with a jaw gap of 79 inches for horizontal and vertical suspension.

While it is true that an electric riveter in itself does not represent any particular novelty, it is maintained that all the other existing arrangements have the disadvantage of the motor running the risk of burning-up in consequence of the shock and great current variation. With these German electric riveting machines the motor is on the same shaft with the flywheel, the latter accumulating energy during the idle part of the operation; for this reason the motor is safeguarded and its burning-up is said to be absolutely impossible. It is also maintained that there is the additional advantage of an extremely low current consumption and loss of power.

As seen in the illustration, the machine consists of a steel casting having on its upper part the lever mechanism as on the pneumatic riveting machines. This lever is actuated by a connecting rod, which in turn is operated by an electric motor through a worm and worm gear. Movement of the lever and cup-shaped die is obtained by the engagement of a clutch-coupling. An accurately operating slide coupling is used, and is set in such a manner that it will throw out at the maximum pressure, and therefore unfailingly safeguards the machine and its parts from being damaged. A fuse protects the motor from excessive overload charge should the cup-shaped dies happen to be inaccurately set.

The cost of operation as well as the initial outlay, is extremely low for the reason that the central compressor station equipment necessary with pneumatic or hydraulic machines is not required. The capacity is said to be quite large as more than 200 rivets can be placed per hour provided that the workmen are able to follow the machine at this speed. This rate may be still further increased it is claimed, since a machine for rivets of 1-inch diameter makes 18 strokes a minute.

It is also claimed that in spite of this rapid production finished rivets of the best quality are obtained, and when the rivet is put into the hole properly the sheet and rivet become completely welded together as has been found when cutting through the rivet in a test piece.

The power required to operate is quite small. A machine forming heads on rivets of ¾-inch diameter requires a two-horsepower motor and for rivets of 1-inch diameter, one of 3.5 horsepower gives a working reserve of fully 50 per cent. The loss of power is also said to be extremely low. With a motor of the continuous current type, 220 volts pressure, it has been found that during the operation of the machine without load only from two to three amperes were used, while during the riveting process from eight to ten amperes were consumed. These results are undoubtedly of great interest as it is claimed they cannot be attained by either the pneumatic or hydraulic process. The low-power demands of the machine are said to be due to the fact that the motor mounted on the machine does not at the moment of riveting perform all of the work itself, but brings into service the flywheel, the momentum of the latter doing the work.

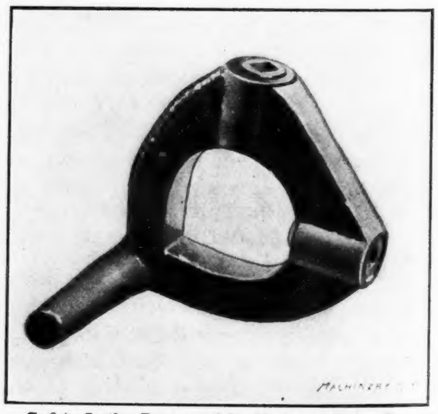
This German system of electric riveting is said to provide absolute safety in operation, for the safety coupling arranged within the flywheel throws out under excessive pressure and the blowing of the fuse breaks the circuit should the motor become heavily overloaded.

* Address: Erie Co. Bank Bldg., Buffalo, N. Y.

* * *

LATHE DOG WITH NON-PROTRUDING SET-SCREWS

The illustration shows a safety lathe dog used by the National Tube Co., Pittsburg, Pa., having two hollow set-screws instead of the usual protruding square-head set-screws. The set-screws are made with square sockets and are larger in diameter than the square-head set-screws usually employed with the ordinary lathe dogs of corresponding capacity. The advantage of this form of dog, of course, is that, having no protruding set-screws, the workman is not likely to have his sleeve caught and arm mangled by the revolving screws when filing, polishing, etc. A disadvantage is that the large diameter of screws necessary to accommodate a wrench shank of the required strength makes it harder to tighten the screws snugly on the work than with the ordinary type.



Safety Lathe Dog used by National Tube Co.

This dog is part of the National Tube Co.'s interesting and instructive exhibit of safety devices and signs in the American Museum of Safety, 29 West 39th St., New York.

* * *

We may declaim against "hot air" all we please, but just the same, way down in his heart, every man likes and appreciates a little flattery now and then, especially if it is given judiciously and artistically.—*The Wood-worker.*

TINNING CAST-IRON CROSSHEAD SLIPPERS

By FOREMAN TINNER

The process of thoroughly tinning cast iron is not understood by many persons to whom it should be familiar, and for the benefit of these, the writer will briefly outline the method generally employed for this work.

To tin a number of cast-iron slippers at once, as required by M. H. W. in his query which appeared in the How and Why columns of the February number of MACHINERY, a small tin-dipping plant is necessary, as it is best to entirely immerse the slippers in the molten tin. The dipping plant should consist of the following: Acid tanks, tinning baths, water tanks and drying receptacles, etc. The tank for the acid and the cleaning liquid are generally rectangular boxes of a suitable size; and if it be desired to economize, an oil barrel sawn in halves will make two suitable tanks. It is sometimes considered advisable to have the acid tanks lined with lead; but this is by no means necessary, and the expense may well be saved. The tinning baths should be made of the best fire-box steel, not less than half an inch thick. To obtain a satisfactory coating of tin on the repaired cast-iron slippers, it is essential that all grease be thoroughly removed, which can be done by washing in a hot solution of caustic soda and water, and then rinsing in clean water. The old babbitt metal must also be removed; this can be done by immersing a number of the slippers in a molten metal bath. Care must be taken when immersing them, for if they are not perfectly dry, the metal "spits." To avoid this, the slippers should be first placed on a coke fire around the metal pot in order to dry.

New cast-iron slippers always have some sand (silica) adhering to them, which should be removed with hydrofluoric acid and water. The most suitable strength is 1 in 20. Sulphuric or muriatic acid is often used, but hydrofluoric acid is preferable, for it dissolves the sand, not merely dislodging it, and at the same time does not attack the iron as the other acids do. The pickle should be kept warm by means of a steam jet, for quicker results are thus obtained; a good temperature is about 150 degrees F. Caution must be exercised during the process to keep the surfaces in the bath from coming in contact with each other, as this would prevent the acid from doing its work. The slippers should be examined occasionally while in the pickle, and any sand or black spots should be removed by means of a stiff wire brush. Overpickling pits the castings, and care must be taken to avoid it. The length of time of pickling will depend upon the temperature and strength of the acid, and on the condition of the slipper casting surfaces.

After being thoroughly cleansed, the slippers should be immersed in a tank of clean water. If it is desired to keep the cleansed slippers for any length of time, they may be preserved from oxidation by being left under the water until they are ready for the tinning bath. When the tinning bath is ready (only the best block tin should be used), the slippers should be immersed in a boiling solution of caustic soda or potash, for about two minutes, then rinsed in water, and then in a bath consisting of a weak muriatic acid solution (1 in 40). The next step is to immerse them in muriate of zinc solution (zinc chloride). This is made by dissolving zinc in muriatic acid to the saturation point, and to every gallon of this solution, adding five pounds of salammoniac. Finally immerse in the first tinning bath at 500 degrees F. Great care should be taken, not to let the tin become red-hot, as undue heating would spoil the surface of the casting, giving it a "dry" appearance; at the same time it accelerates the formation of dross.

The bath should have a special flux on the surface, prepared by boiling muriate of zinc on top of the tin and adding thereto some salammoniac. The proper consistency of this flux is essential to good work. If it tends to become thick or hard, add more of both ingredients, and remove any hard part with a skimmer. The castings, as just mentioned, are immersed in this bath, the same care being taken as with the repaired slippers; they are afterwards taken out by means of suitable tongs.

The slippers next go to the second tinning bath. Care should be taken that none of the surface slag or flux is taken by the work into this bath. The bath should have a layer of tallow on the top, to the depth of half an inch, and when the slippers have been withdrawn from it, which may be at any convenient time after the tin is set, they may be thrown into a clean sawdust receptacle, which takes up the oil.

The operation of tinning is now complete, and if the proper method has been followed, and care exercised, the slippers will have a smooth coating, uniform in depth and color. It is a decided advantage to line the slippers with the babbitt metal immediately after they are tinned and cleansed, so as to avoid the time and expense of re-heating.

* * *

THE BABBITT MINE

By A. TRAVELER

"Yes," said Dornbirer, "I had some interesting and peculiar experiences out in the natural gas country, where I worked, you know, several years as a repair man, but the most profitable was the discovery of a babbitt mine.

"No, babbitt is not a natural metal, of course, and the mine was really a deposit formed as a result of careless shop management. Right here let me say that if all the leaks in the shops of this country made as rich and easily worked byproducts as did this one, the ground underneath some of our plants would be richer than the Comstock lode. You see, it was this way, Josh Brown was a natural promoter. He found out early in life that 'a sucker is born every minute,' and that his business genius was the faculty of getting the suckers. Well, Josh formed a 'syndicate' to manufacture wood pulp. It was afterward spelled 'skindicate' by those who got skinned, but that is getting ahead of my story. The syndicate looked around for a bunch of 'easy marks' and found them all right out in the natural gas region, where a lot of people had salted away easy money in bales. The town was to put up $100,000 for the privilege of having the wood pulp mill in its midst. Mind you, no guarantee was given as to how long the mill was to stay or how many men it was to employ.

"The mill was built and put into operation. It was hastily erected, poorly laid out and gave unlimited trouble almost from the start; but our chief trouble was with a ten-inch shaft direct-connected to the engine, running longitudinally through the mill to the grinders. This shaft soon got out of line and then the main bearing next to the crank was cut out. It was next to impossible to take out the bearing. The whole mill would have been dismantled, as it would have been necessary to raise the whole shaft up to get that box out. That fact gives you an idea how badly the mill was designed.

"Well, we had to rig up and babbitt that box in place the best way we could manage. The first time we tried it with 75 pounds of best babbitt that cost 25 cents a pound; but would you believe it, it didn't half fill that box, and another 75 pounds was poured into it before it was filled. You see, the shaft was out of line, and we didn't put it right, so it wasn't a week before the box was as badly cut as before, and another 150 pounds of babbitt went into it. It got to be a regular thing to babbitt that cussed box every Saturday night, and the purchasing agent bought babbitt by the ton. It surely did come high—25 cents a pound is $500 a ton, and that's going some, I tell you, when you use a ton every three months.

"We used to wonder what became of the babbitt, but so long as the bosses didn't care, we didn't worry, and things ran along from bad to worse until the stockholders got sick of the business and finally refused to put up any more cash to run a losing game.

"The mill shut down and stood idle a year. Meanwhile the prospects of making a wood pulp mill pay, so far from the source of timber supply, grew slimmer and slimmer. Finally it was decided to dismantle the mill and sell the machinery for what it would bring. I had found another job in the town, so I wasn't worrying about the failure of the mill; but

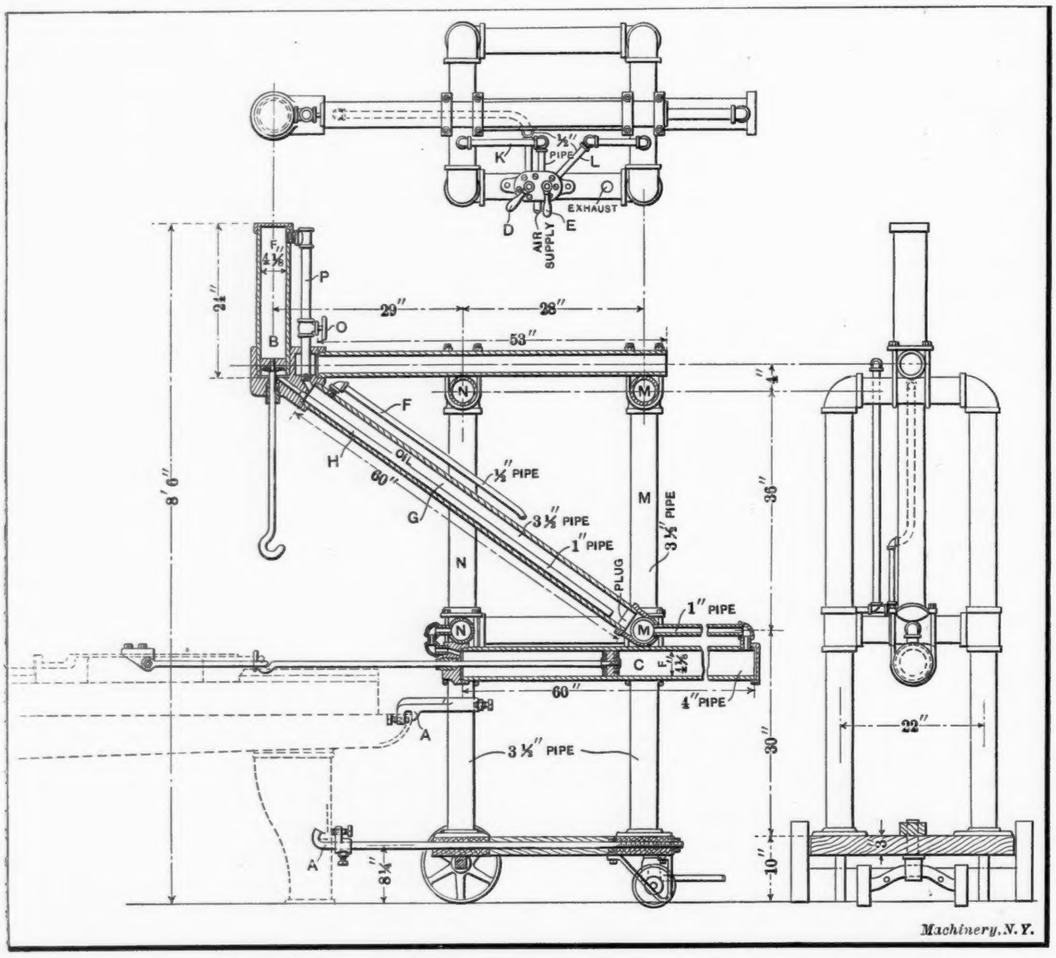
one day I was thinking of all the babbitt we had used in that main bearing box, and I had a good idea what became of it. You see, the mill had no basement. It was set on stone piers about 3 feet above the ground. The soil out there, you know, is nothing but sand in some places, and underneath that mill was a sandy streak—just nothing but loose white sand.

"I went to the contractor, a kind of Jew, and made an agreement to pay him $100 for all the junk left on the ground after he had cleaned up. He snapped me up quicker than a wink, and chuckled when I paid over the money. He seemed to kind o' think 'there wasn't going to be any core.' To tell the truth there wasn't much in sight that could be converted into ready cash when Mr. Contractor finally quit, but I didn't worry—for the simple reason that I had done some prospecting before I made the deal. I had jammed a crow-bar down in the sand underneath the place where we had poured so much babbitt into that box, and the bar struck something solid that was neither stone nor iron. See? Well, we shoveled about a foot of sand and uncovered a mass of babbitt ten feet across. I couldn't budge it with a long bar, and sent my partner off for a team, feeling pretty good I can tell you. When we got the team there we hitched on and you ought to have seen them pull. We dug all around it, but they couldn't drag it out. It took two of the best teams in town to pull that ragged block of metal out of that hole. I sold it to a junk man at 9 cents a pound, and you can figure up how much there was when I tell you that I cleared $1400 on the deal.

"You see, there was a blow-hole in the bottom of the cast-iron pedestal, and the biggest part of the babbitt that we had poured in ran out at that little hole down in the loose sand beneath. You don't believe it? Well, I don't blame you, but it's so."

* * *

Barring few exceptions, upright drilling machines show very little improvement in design or manufacture over those built twenty years ago. The same awkward lines prevail and the same methods of fitting. Soft patches, babbitted boxes in cored holes and other practices, good in their day but out of keeping with modern methods, still prevail.



Pneumatic-Hydraulic Hoist and Machine Slide Pulling Device used in the Jones & Lamson Machine Co.'s Shop, Springfield, Vt.

PNEUMATIC-HYDRAULIC DEVICE FOR PULLING SLIDES WHEN SCRAPING

Several devices for mechanically pulling machine slides over the beds to which they are to be fitted by scraping, were described in an article entitled "Labor-saving Devices for Scraping Operations," published in the April, 1909, number of MACHINERY. The accompanying illustration shows a device for the same purpose which is in use in the erecting shop of the Jones & Lamson Machine Co., Springfield, Vt. The device is a combination hoist and pulling and pushing apparatus, operated by compressed air in combination with oil, the compressed air exerting a pressure upon the oil, which, in turn, exerts the required pressure upon the operating pistons. The apparatus is mounted on a truck, so that it can be conveniently moved to any part of the shop.

When in use it is securely fastened to the bed of the machine on which the slide is to be scraped in, the clamps used for this purpose being shown at *A* in the engraving. The cylinder *B* is the hoisting cylinder, and cylinder *C* contains the piston which operates the slide as shown. The valve *D* controls the pressure in the hoisting cylinder, and the valve *E* the pressure in the pulling and pushing cylinder. When valve *D* is opened to admit the air, the latter enters through pipe *F* into the oil chamber *G*, from which the oil pressure is transmitted to the under side of the piston in cylinder *B* by means of pipe *H*. When the piston is to be lowered, the air is exhausted and the oil, returning to the reservoir *G* by means of the small pipe *H*, prevents a too sudden drop of the piston and its load.

When the slide pulling and pushing device is to be operated, the valve *E* admits the air pressure either to pipe *K* or pipe *L*, from which it is transmitted to the oil in the reservoir formed by the pipes marked *N* and *M*, respectively. When the pressure acts on the oil in the reservoir *N*, the piston is moved to the right, pulling the slide, and when the pressure acts on the oil in reservoir *M*, the piston moves to the left, the slide being pushed forward. It is evident that when the air is admitted on one side, it is exhausted on the other. The pipe *P* and the handwheel-operated valve *O* permit any oil that may leak by the piston in cylinder *B* to return to the oil reservoir *G*. At the upper end of pipe *P* there is a small vent-hole permitting the air above the piston to escape when the hoist is in operation.

* * *

The firm of Ernst Schiess, of Düsseldorf, Germany, has just completed what is believed to be the largest lathe in the world. It is intended for turning heavy steam turbine shafts and rotors, weighing up to 165 tons. The lathe will swing parts up to 16½ feet in diameter. The greatest distance between centers is 53 feet, and the total length of the lathe is nearly 80 feet. The lathe is motor driven, three motors being used, the main driving motor having a capacity of 80 H. P. The total weight of the lathe is 385 tons.

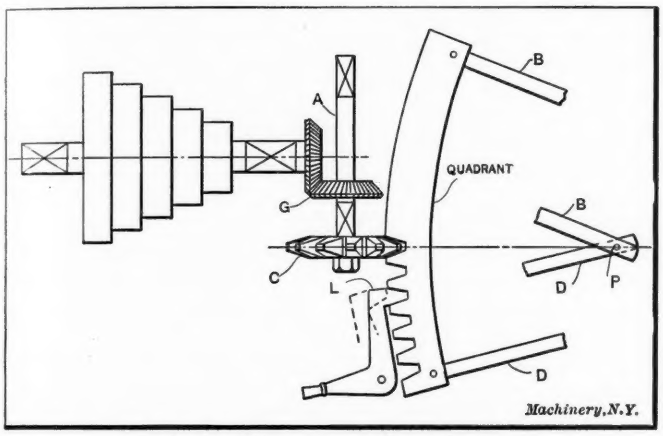
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

MILLING A REVERSE LEVER QUADRANT

A milling fixture used by H. T. Mills, toolroom foreman in the Fort Wayne shops of the Pennsylvania Railroad, is shown diagrammatically in the accompanying sketch. It allows the notches in reverse lever quadrants of any radius to be satisfactorily and quickly milled. While the indexing is not done with the precision of a dividing head, and would not be sufficiently accurate for most gear teeth, it answers admirably for its purpose.

An old plain miller, about the size of a present-day No. 1 is used, a bracket being bolted over the end of the spindle nose to carry a cutter arbor *A*, at right angles to the milling machine spindle. This arbor is driven from the spindle



Device for Milling a Reverse Lever Quadrant

through a pair of bevel gears *G*. A cutter *C* is carried outside of the bearings.

The quadrant to be milled is strapped to the top of the table. Guide rods *B* and *D* extend from the ends of the quadrant to a pivot point *P* on an outboard support at the center of curvature of the quadrant.

The first two or three notches are laid out on the quadrant by scale, and the slots are milled by feeding the table with the work up past the cutter. After this, the indexing for successive notches is obtained by a latch *L* which engages each one of the notches in turn after it has been milled. Thus whatever spacing was laid out for the first two or three notches is duplicated for all of the others.

Cincinnati, O. HENRY M. WOOD

SHAPE OF DRAWING EDGES IN SHEET-METAL DRAWING DIES

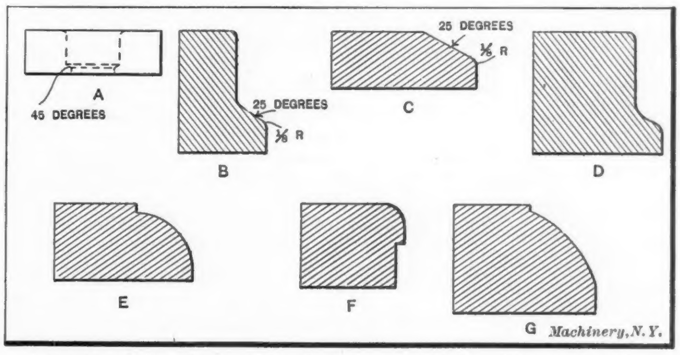
Many interesting articles on the drawing of sheet metal have been published in MACHINERY and other technical magazines, but nowhere has the writer run across definite instructions or rules as to the proper way of making the drawing edges on such dies. The drawing process for sheet metal, whether hot or cold, by which deep cylindrical or cup shaped articles are made from a flat sheet is very different from the ordinary bending of strips or operations of like nature, and embodies certain entirely different principles. There is present an interesting example of the "flow" of metals, and mechanics know that such flow takes place without weakening the metal, it merely growing harder or firmer, in the same way as it does when subjected to rolling or hammering.

Sheet-metal drawing consists in confining the blank which is to be drawn between two rigid surfaces, so that the metal cannot wrinkle when being pulled radially inward, which it has a tendency to do on account of the constantly decreasing circumference of its edge. When redrawing with inside blank-holders, the lower corners only are held firmly, the walls of the cups being supported, to prevent wrinkling or overlapping, from the inside. For some tin-work of large diameter, the writer, when reducing from the first "draw," has been obliged to hold the walls of the work between an inside and an outside surface to prevent wrinkles and irregularities.

While in the writer's experience the corners have been made of various angles, curves and radii to allow the metal to freely flow into the drawing die, no fixed rule has been followed, nor is he certain as to just what angle or radii drawing and redrawing dies should have to produce the best results. A tentative rule that has been of considerable help when using blank-holders, is to make the corner of the drawing die of a radius equal to six times the thickness of the metal. For redrawing with an inside blank-holder, the face of the die is made with an angle of from 25 to 30 degrees from the horizontal, and with about 1/8 inch radius to remove the sharp corner. Owing to the wide variation of the work and uncertain conditions, the possibility of formulating exact rules is doubtful. Notwithstanding this, it would be interesting to hear from readers of MACHINERY pertaining to their experience along this particular line.

The illustrations in the accompanying engraving are not submitted as examples of how drawing die edges should be made, but only to show how they have been made in the writer's experience. It is hoped that this will bring about a discussion of a subject that is steadily growing in importance, and elicit information from more experienced mechanics.

The figures as indicated are: *A*, an outline of a cartridge redrawing die having a drawing edge at an angle of 45 degrees; *B*, is a reducing die for a large cup; *C* a redrawing die to use with an inside blank-holder; *D*, another type of redrawing die, the reducing part, or drawing edge being in the form of a reversed curve; *E*, a cupping die for thick stock to be used without blank-holder; *F*, a cupping die to operate with



Examples of the Shape of Drawing Edges for Sheet-metal Drawing Dies

blank-holder; and *G*, a die similar to that at *E*, the only difference being the long curve of the drawing edge, this die being used for extra-thick stock. The straight part of the reduced portion of the dies is made from a minimum of 1/16 inch to a maximum of 3/4 inch, but never more than the latter dimension, even for the very heaviest work, whether hot or cold.

Milwaukee, Wis. C. H. ROWE

A USEFUL MILLING MACHINE VISE

In factories manufacturing machines of sheet metal or machines using light uniform castings or forgings, the milling machine plays a very important part. The principal reason lies in the expeditious manner in which sheet-metal parts may be edge-milled with an additional cost for fixtures, of only one vise jaw and a suitable cutter. This is a comparatively small outlay as compared with that necessary for a shaving die to perform the same operation. Comparing the two processes, the speed of production is about the same, while the quality of work is somewhat in favor of milling.

The accompanying drawings clearly show the construction of a semi-automatic vise that was designed for use in a large adding machine factory, and which has proved through long use to be all that could be desired. While there have been many more or less automatic fixtures devised in the last few years, very few of them have proved as successful as this.

Fig. 1 shows its general construction, and the relative locations of the milling cutter at its extreme positions are indicated. The vise consists of a cast-iron body *A*, and has two machinery steel tongues *B* that fit into the slots of the milling machine table, to which it is conveniently bolted in the customary manner. In this main casting *A*, there is a sliding

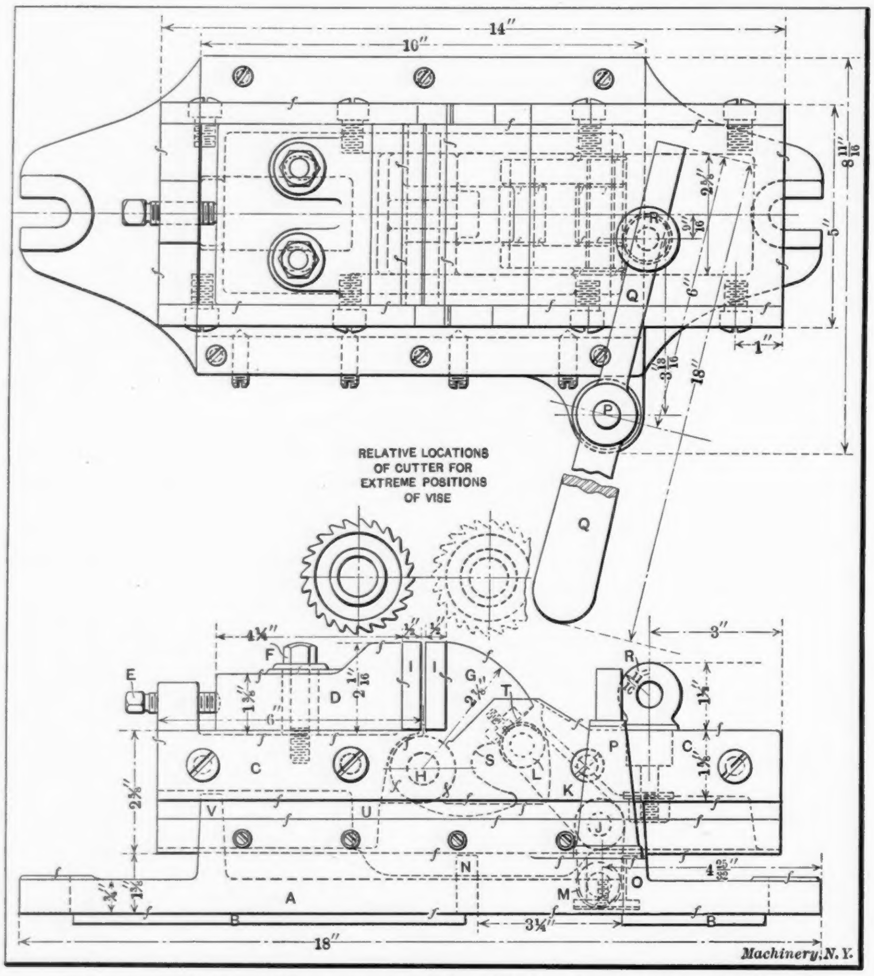


Fig. 1. Assembly View of Semi-automatic Milling Machine Vise for Milling Thin Pieces

piece *C*, which is the operative part of the vise. It slides in recessed grooves on either side of the main casting *A*.

On this casting *C*, are the two vise jaws. The jaw *D* is adjustable for the different sized articles to be machined, by means of the set-screw *E*, which bears up against the end of this casting, and in combination with bolt *F*, which clamps the jaw when located, holds it rigidly. The other jaw *G* is attached to the casting *C* by pin *H* on which it swings, as shall be explained later. This swinging jaw *G* is shown more in detail in Fig. 2. Both these jaws have faces *I*, of casehardened machinery steel, which clamp the article to be machined.

Pivoted at *J* there is a bell crank *K*, shown in detail in Fig. 3, on each end of which there are rollers *L* and *M*. The lower

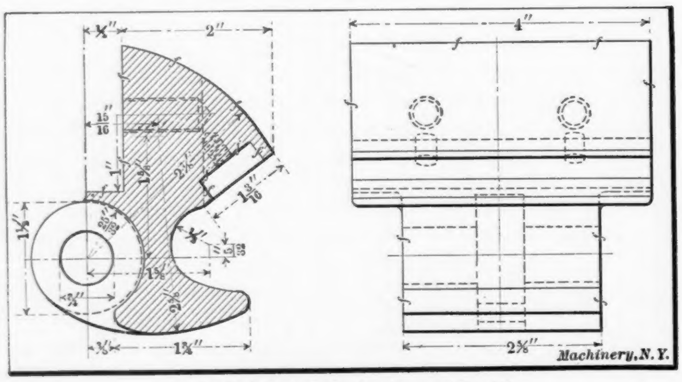


Fig. 2. Detail of Swinging Jaw of the Vise

portion of the bell crank passes into an opening in the bottom of the main casting *A*, at each end of which are shoulders *N* and *O* against which the roller *M* strikes.

Fixed in the main casting *A* there is a vertical post *P*, attached to which is a lever *Q* passing through a swivel bolt *R* in the sliding casting *C*. The lever *Q*, operating in either direction, moves the part *C* backward and forward, in the main casting *A*.

The operation is as follows: Suppose that the article to be milled is in the vise between the jaws *D* and *G*, the positions of the various parts being as shown. The milling cutter will be to the left, as shown in full, and a movement of the handle *Q* to the right moves the sliding part *C* to the left, forcing the article to be milled under the cutter. The relative position of the cutter will then be to the right, as shown dotted. When this sliding part *C* has moved a certain distance to the left the roller *M* strikes the face of the stop *N* and as the motion of *C* continues to the left, the bell crank *K* will swing in a counter-clockwise manner, the roller *L* dropping into the recess *S* from the inserted face *T* which has a taper of 3 degrees. The roller *L* dropping into this recess, permits the jaw *G* to drop by its own weight, swinging about center pin *H*. This releases the work.

In order that the motion of *C* may not be so great as to jam the parts, stop *U* on *C* comes in contact with stop *V* on the stationary casting *A* before it moves too far, preventing further motion. When the jaw *G* has thus swung down, the work falls with it, dropping below the cutting line, lying back at an angle so that when the lever *Q* is again moved to the left, the article being milled will not strike the cutter.

When the sliding part *C* has moved the major portion of its distance to the right, roller *M* strikes the face of stop *O*. At this point the cutter being to the left of the jaws, the finished work may be removed and a fresh piece inserted on the sloping face of jaw *G*, when the motion of the lever *Q* may be continued to the left, which moves *C* to its extreme position on the right, forcing roller *M* against the face of *O*, which lifts the bell crank *K* so that roller *L* leaves the recess *S* and moves up along face *T*, clamping the article to be

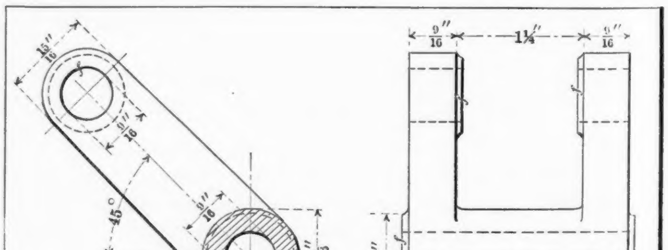


Fig. 3. Detail of Bell-crank which operates the Swinging Jaw of the Vise

milled in the vise, when the operation may be repeated as before.

While from the explanation, the operation may seem rather lengthy, consideration will show that the movements are very rapid and only require a motion of the lever *Q* in either direction to perform all the work necessary for the operation of the vise, so that, as will be seen, the action is really semi-automatic.

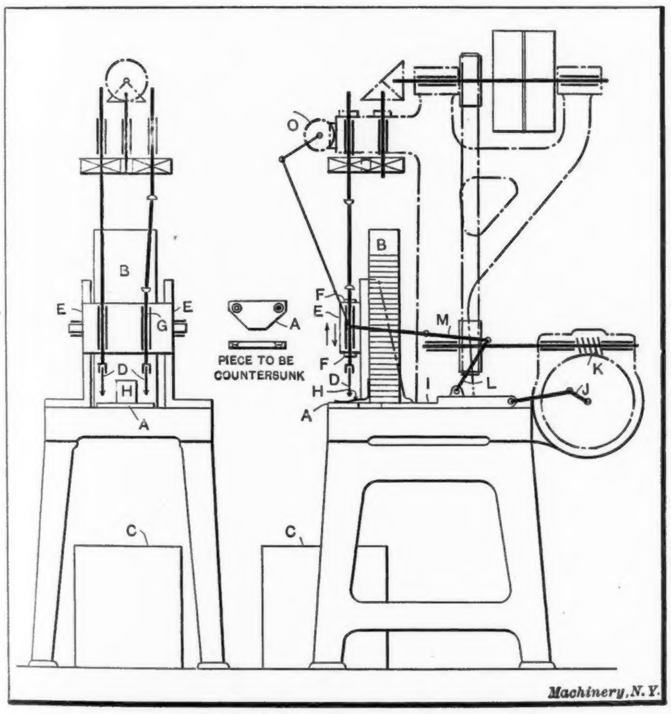
ST. LOUIS

AUTOMATIC COUNTERSINKING MACHINE

Some time ago the writer had the opportunity of seeing a machine similar to the one here illustrated, and realizing that the principles upon which it was designed might be of interest in the future, he made sketches of it in his note-book. The engraving cannot be considered as a scale drawing, for the original was only a diagrammatic sketch, intended merely to illustrate the operation.

The purpose of the machine was to countersink simultaneously both holes of the piece *A*, shown in the detail view. The pieces, after being placed in a chute *B*, were automatically fed into the mechanism, reamed, and finally discharged into the box *C*. Previous to these operations, however, the holes were punched in another machine. The accompanying illustration is practically self-explanatory of the method of operation. Spindles *D* driven from above, are journaled in a sliding head *E*, and are vertically secured in this head by the collars *F*. In order that the machine can be used for countersinking holes the distance apart of which varies, one of these heads *G* has a cross-wise adjustment. To make this practicable, this shaft is driven by universal joints.

The piece being countersunk is held in position by the spring clamp *H*. The plunger *I*, passing under the chute *B*, feeds the pieces *A* forward, one at a time, and at the same time ejects the reamed piece into the box *C*. This plunger or slide *I* is actuated by the crank *J*, to which it is connected by a connecting-rod. The crank *J*, in turn, is driven through a worm gear and worm *K*, the latter being on a shaft driven by a belt on the main drive shaft. The plunger *I* also actuates the feed through the levers *L* and *M*, the latter of which is pivoted



Automatic Countersinking Machine and Piece operated on

near its center. As *J* revolves, it successively forces the countersinks into the work, and introduces the new piece, at the same time ejecting the finished article.

The number of pieces produced are counted by the number-counter *O*, connected, as shown, to the sliding head *E*. It will be seen that the only labor required is to see that the feed chute is kept supplied, and that the box for the finished pieces is emptied from time to time. Everything else is automatically cared for. E. Kwartz

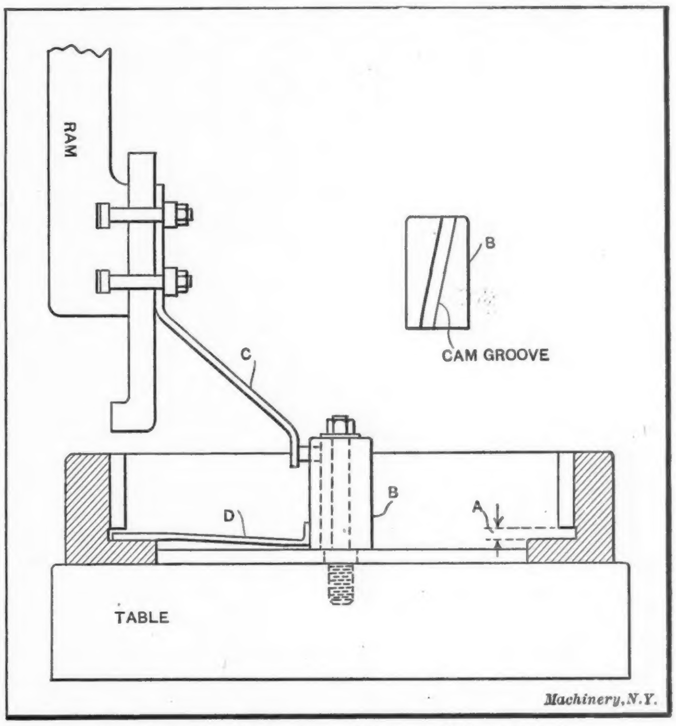
Chicago, Ill.

A HELPFUL HINT FOR THE SHOP

The cutting of the teeth of a large internal gear is not an unusual or difficult job for the slotter, yet when there is only ⅜-inch clearance between the end of the cut and the gear wall, it makes a rather tiresome day for the operator to stand constantly by his machine ready to clean out the chips from the groove at every stroke and thereby keep the tool from jamming.

A job of this nature comes in frequently in large lots so that the device shown in the accompanying figure was made, the results from which have been very satisfactory. While the chips are not all cleaned off the flange, they are pushed back sufficiently so that at least one complete tooth can be cut without attention. The clearance is shown at *A*.

The device which is a very simple one consists essentially of



Method of Cleaning an Internal Gear of Chips while the Teeth are being slotted

a cast-iron bushing *B* in which there is a cam groove. This is oscillated on a stud fitted into the slotter table, by means of a flat piece of stock *C*, bent to suit, which projects from the slotter ram, and on the end of which there is a cam roll. The motion of the ram transmits, by means of the cam groove, an oscillating motion to the sleeve, and the arm *D*, secured to the latter, sways back and forth at each stroke under the tooth being cut, thereby keeping the space free from chips.

Plainfield, N. J. H. Terhune

TOOL GUIDE ATTACHMENT FOR THE PLANER

Fig. 1 shows a casting which usually necessitated two settings on the planer to finish the surfaces *A* and *B*. This was

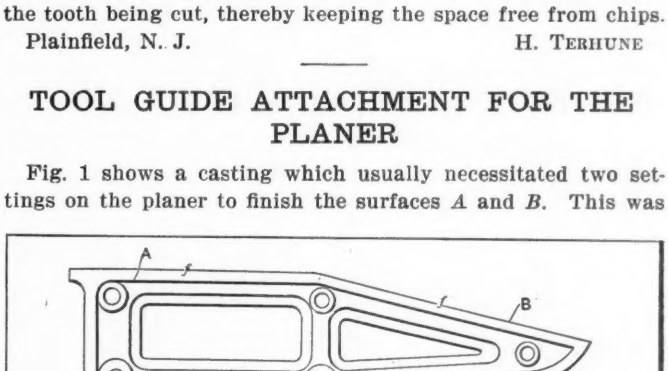


Fig. 1. Casting to be planed. Fig. 2. Templet used for Guiding the Tool

a difficult job, to say the least, as it required accurate setting to bring the two faces in the desired relation to each other. To facilitate this, the device shown in Fig. 3 was adopted.

This consists mainly of a tool-holder *A*, held in the planer head, and carrying a sliding member *B* of square section, in which is held a cutting tool *C*. A boss *D* is attached to one end of the bar *B*, in which is held a spindle carrying a roll *E*. The tool is guided by a templet *F*, which is clamped to the table of the planer. A detailed view of this guide is shown in Fig. 2.

In operation, the work, Fig. 1, is set up on parallels, so that the roll *E* does not touch the bottom of the groove in the guide; of course, the whole job should be set as close to the planer head as possible to prevent chattering. The guide *E* is set to correspond with the casting, Fig. 1, when the face *B* is parallel with the stroke of the planer. This prevents the tool from "digging in" when planing the surface *A*, as the tool is drawn *from* the work. This arrangement, of course, is only suitable for light cuts, but nevertheless, it is a good deal quicker than setting up for planing each face of the casting separately.

CHIPS

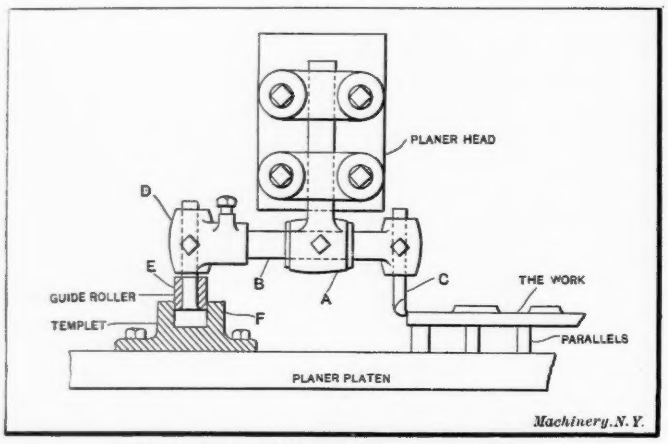
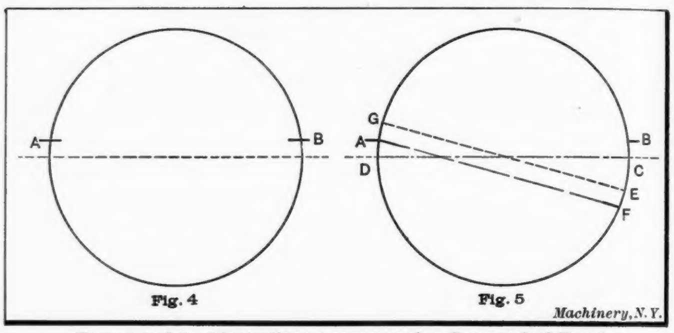


Fig. 3. Tool-guide Device set up on the Planer

SCRIBING A CENTER LINE ON CYLINDRICAL WORK

An accurate and useful method of locating an exact center line on a lathe faceplate or any job in a lathe, such as a gun, breech-blocks, jigs, dies, etc., is explained in the following. The surface of the work should first be prepared so that a fine line scribed with a sharp surface gage point will show up well. If the metal is steel or cast iron, blue vitriol can be used to advantage. By dissolving a crystal of blue vitriol, the size of a walnut, in a cupful of water with a few drops of sulphuric acid, a mixture will be obtained that, when applied to a finished surface on cast iron, wrought iron or steel, will produce a thin coating of copper so that scribed lines can easily be seen. The tools necessary are a surface gage and a piece of metal having one true surface for the gage to slide upon. This piece should be long enough to reach across the shears of the lathe, and it should rest firmly without any rocking movement.

After the bar *S* is placed on the shears of the lathe, as illustrated in Fig. 1, with the true surface uppermost, place the surface gage on it with the pointer set as nearly central with the work as possible, and scribe light lines *A* and *B*; then with the gage pointer on the left side, turn the faceplate or chuck by hand until the line *B* moves around far enough to coincide with the pointer, as shown in Fig. 2. The lines *A* and *B* will then occupy the positions shown by the full lines, the dotted lines showing their original positions. The location of these lines above the center has been exaggerated in order to more clearly illustrate this method. The surface gage is now moved to the right side and another short line is scribed where *B* was originally. The gage pointer should, of course, remain undisturbed throughout the operation. The space *A-B* is next divided into four equal parts, as illustrated in Fig. 3, and the third division, counting from *A*, will be on the center line, which can then be scribed with the surface gage as shown. In most cases it will be necessary to divide *A-B* into four parts by guess, owing to the small space between these points.

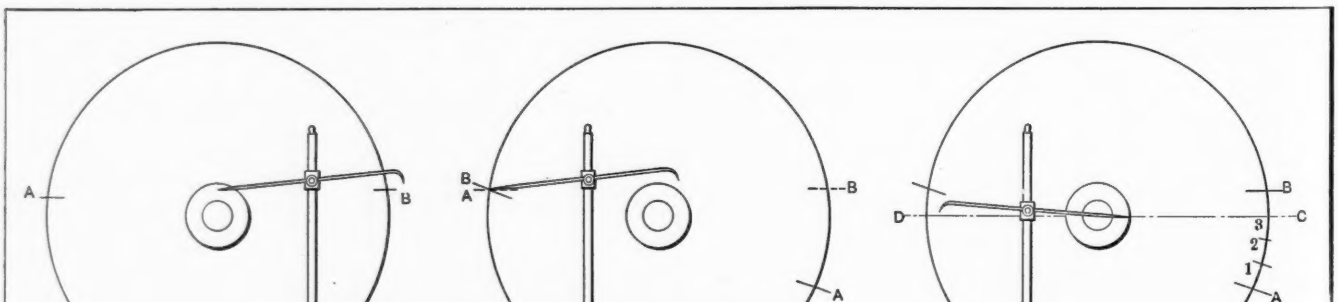


Figs. 4 and 5. Illustrations accompanying Geometrical Proof

The work can be proved by starting on another part of the circle, and, without moving the surface gage pointer, repeating the whole operation. If this work is carefully performed, accurate results can be obtained, providing the surface operated on is finished nicely and a fine gage point is used.

The geometrical proof of the method, which may interest some, is as follows: In Fig. 4 let the circle represent the faceplate of the lathe. The lines *A* and *B*, are the trial lines and the center line is shown dotted; Fig. 5 represents the faceplate turned so that line *B* is at *A*. *C-F* which is the distance wanted, is a curved line, but, in practice, it will be so short that the curvature need not be considered. By construction, in Fig. 5, space $A\text{-}D = A\text{-}G = F\text{-}E = B\text{-}C$, and $C\text{-}E = D\text{-}G$, for they subtend equal angles at the center of the circle. Then $C\text{-}E = 2\ A\text{-}G$ or $F\text{-}E + B\text{-}C$. Therefore $C\text{-}F = \frac{3}{4}$ of $B\text{-}F$, which proves that a line scribed with a surface gage at height *D* in the manner described will be a center line.

Schenectady, N. Y. JAMES H. CARVER



Figs. 1, 2 and 3. Various Steps in Locating Center Line

A CIRCULAR RACK FIXTURE

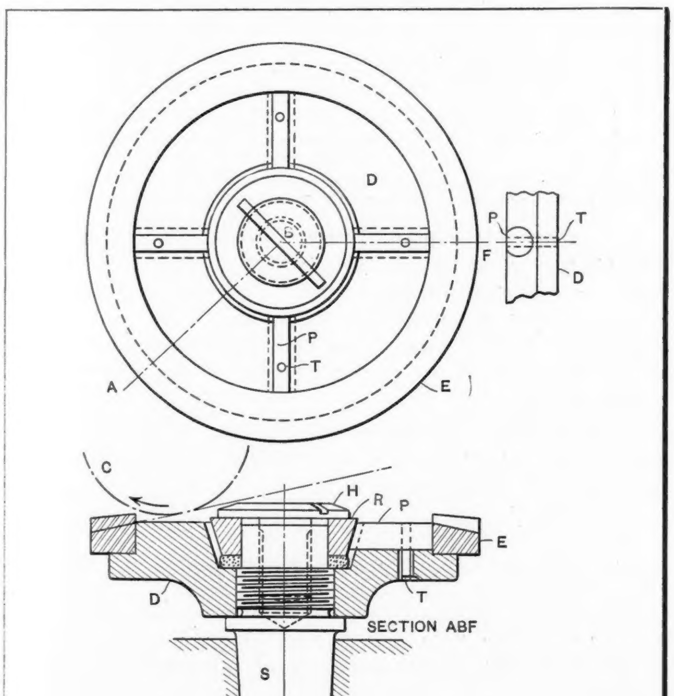
A simple and satisfactory device for holding small circular racks when cutting their teeth is shown in the accompanying illustration. The cutter in the indexing position shown by the dot and dash arc *C* turns as indicated by the arrow and feeds to the left.

The fixture consists of the tapered spindle *S*, the disk *D*, the holding screw *H*, the conical ring *R* and four extension pins *P*. Its action is as follows: The rack *E* is placed in the position shown, but should not fit tightly. By turning the screw *H* the ring *R* is pulled down, spreading the pins *P* which press radially outward against the rack and hold it in position. To remove the rack, the cutter is run to the right out of the way, when by unscrewing *H* the compressed rubber cushion under the ring *R* will raise the latter, releasing the extension pins. The taper of ring *R* should be from 20 to 30 degrees so as not to become friction-bound when screwed down. The small pins *T* prevent the extension pins from turning, but allow them a slight lateral play.

The construction and operation of the fixture will be evident from the drawing, and is such that it may readily be adapted to other proportions. When there is sufficient room, the screw *H* should have a hexagon head in addition to a wide flange; but a washer should never be used under a cap-screw as a substitute, as this would be apt to cock the ring *R*, causing it to bind. When convenient, it is well to replace the screw *H* by a flat-headed bolt, extending through the fixture and machine spindle, and having a hand nut on the lower end.

The following points are worthy of note and will aid one to make the fixture accurately: First, turn and face the taper ring *R* carefully on a straight mandrel. Next, make the tapered spindle *S* and fit its upper end to the ring *R*. Do not bore the screw hole but preserve the centers. Chuck, bore and rough out the disk (top side first), making the taper recess one-eighth inch larger than the ring *R* and leaving depth enough for the rubber spring. One-sixteenth inch should be left on the upper face to facilitate drilling the round extension pin holes. Then rough out the screw hole.

Next, lay out, drill and ream the holes for these pins and



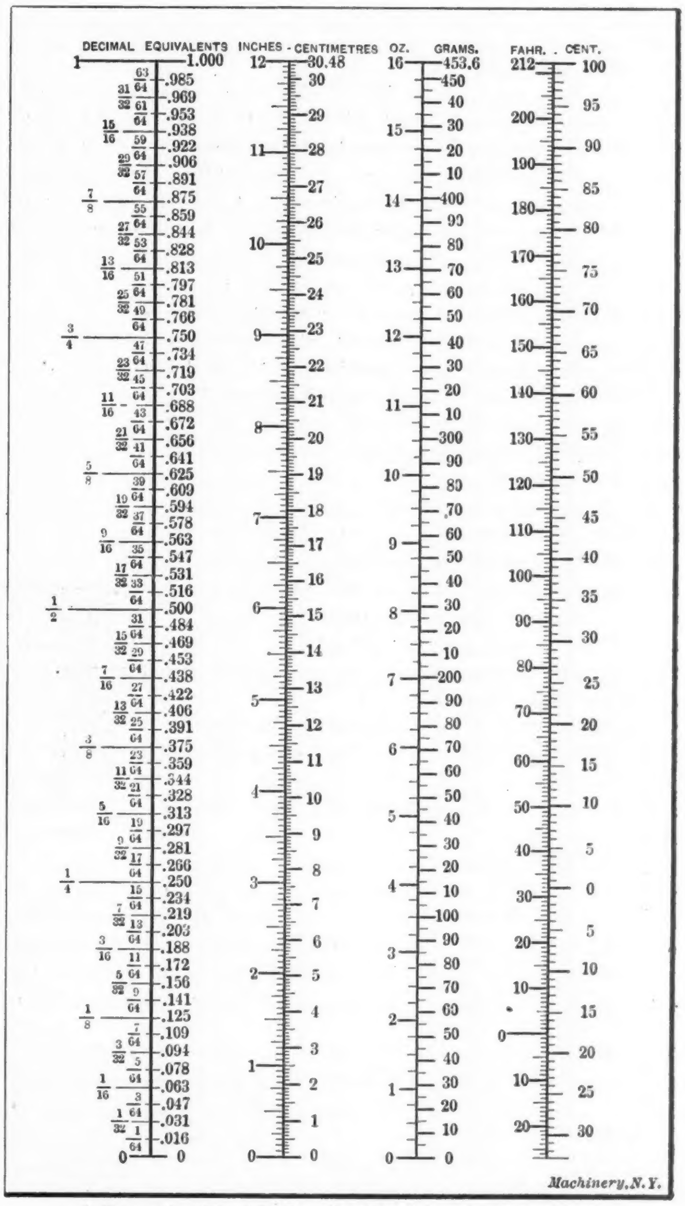
A Circular Rack Fixture

fit them so that they project far enough into the center cavity to finish properly. Fit the dowel pins *T*, but do not enlarge their holes in the disk until later. Now re-chuck the disk with its top face toward the chuck, and bore, thread and face it to fit the spindle thread tightly. Mount the disk, pins, etc., on the spindle centers and finish the upper side of the disk; *i. e.* turn the rack seat and outer ends of the pins *P*, face the disk and bore the inner ends of the pins to fit the ring *R* so that it will project beyond the end of the spindle *S* to allow for adjustment. Remove the spindle and extension pins from the disk and enlarge the holes in the disk for the dowels *T*, as shown in the lower view. Bore and thread the screw hole in the end of the spindle, using a steadyrest, and make the screw to fit. Assemble the fixture and if necessary key the disk to the spindle *S*.

South Bethlehem, Pa. H. A. S. HOWARTH

CONVERSION CHART FOR LENGTHS, WEIGHTS AND TEMPERATURES

The accompanying chart for converting common and decimal fractions, English and metric lengths, English and metric



A Conversion Chart for Lengths, Weights and Temperatures

weights and Fahrenheit and Centigrade thermometer scales was compiled by me for office use. We have found it very convenient and I suggest that the readers of MACHINERY would also find it convenient, especially if made on a larger scale for office use. The original is 10 by 18 inches.

West Lynn, Mass. K. TORNBERG

AN INSIDE MICROMETER GAGE FOR LARGE WORK

Micrometer gages, such as are here illustrated, have been used by the writer on large work for several years and have proved so satisfactory that a description of them would probably be appreciated.

Fig. 1 shows the construction of the micrometer. Essentially it consists of an extension to the typical inside micrometer shown at *A*, the latter having its stem threaded as shown at *B*, with a flat top thread of a pitch of about 40 per inch. This is the only change in the instrument itself. The projections *C* are those found on some makes of inside micrometers.

This inside micrometer is attached to a piece of tubing, as shown, by means of the taper chuck and nut which are detailed in Fig. 2. In both figures, *D* is the inner member of the chuck and *E*, the outer. Nut *F* which screws onto the end of *D*, forces the taper members together, expanding *E* in the tube, and compressing *D* on the micrometer, clamping the whole securely. The inner member *D* is tapped to correspond with the thread of the inside micrometer. A similar arrangement is made at the other end of this piece of tube, where a chuck similar to the one just described is used, only in place of the inner member's being tapped, it is bored smooth, a piece of smaller tube or rod inserted, the end being turned down in the case of the rod, or having a piece sweated in, in the case of the tube, the whole appearing as at the right end of the instrument.

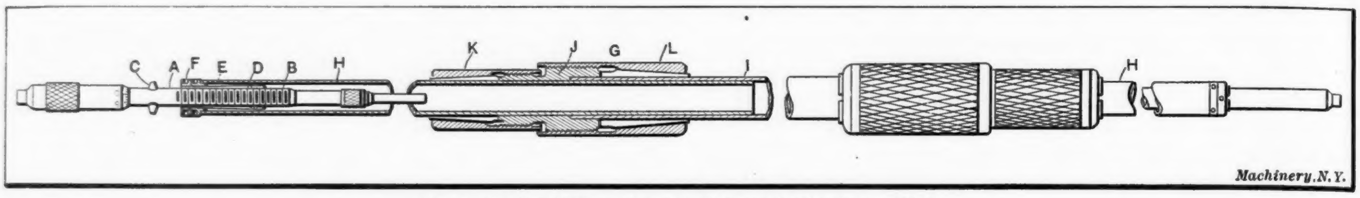


Fig. 1. Sectional View of Inside Micrometer for Large Work

For large work, a piece of heavier tubing, as shown at *I*, Fig. 1, is used for the center part, making the instrument stiffer. Chucks, one of which is shown in section at *G*, join end tubes *H* to the center tube *I*. These chucks are of the common split form. The tightening of knurled nuts *K* and *L* clamps the tubes firmly together.

The portion *B* of the original inside micrometer is threaded in order that exact adjustment may be made by turning the micrometer so that measurements may be taken from zero.

When the larger center portion is used, precautions should be taken that the smaller tube conforms fairly closely with the bore of the larger in order that the creeping tendency, due to unavoidable bending of the instrument might be obviated. As an extra precaution it might be stated that any knocks, even though slight, should be avoided in a gage of this size, whether of the solid or adjustable type. It is always necessary to support such a gage at the same points and in the same way at the measuring machine and while taking a measurement, as otherwise differences in "sag" will slightly alter the length of the gage.

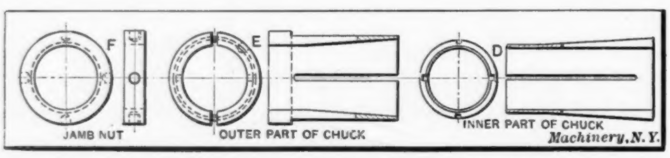


Fig. 2. Details of the Small Clamping Chuck of the Micrometer shown in Fig. 1

As a final word of warning it might be stated that such gages are not to be considered as standard, for no inside micrometer above two feet in length can be considered as such, but should be compared at frequent intervals with the shop standard. Therefore, when the work is large and exacting, it is advisable to calibrate the gage before taking the size of the work and finally checking back on the standard after the measurement has been taken.

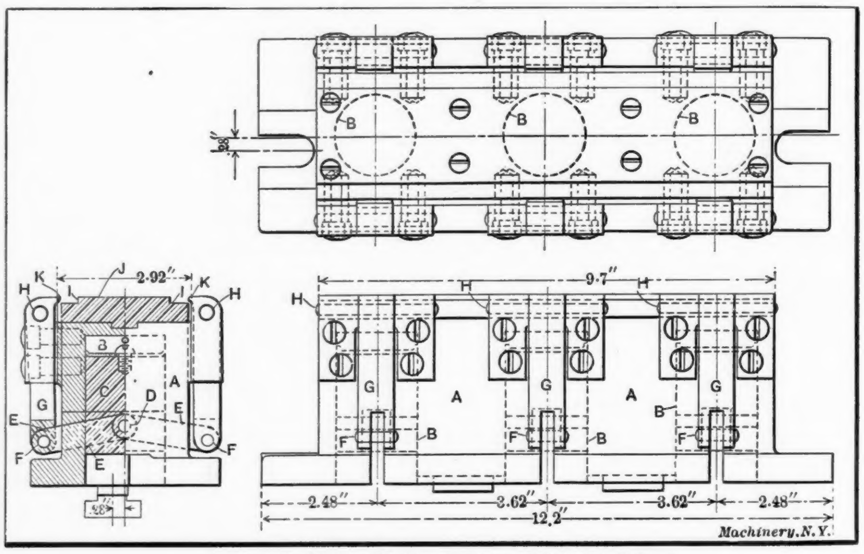
Wm. S. Rowell

Morton Park, Ill.

A PNEUMATIC MILLING FIXTURE WITH QUICK RELEASE

A handy milling fixture as used by one of the largest typewriter firms in the country, is shown in the accompanying assembly drawing.

The base casting *A*, which is bolted to the machine table (offset as indicated by the groove strip), is bored to form three air cylinders, as at *B*. The leather packed plungers *C* connect at *D* to the toggle joint arms *E*, which, in turn, connect through pins *F* to the clamping arms *G*, the latter being pivoted at *H*. Work to be operated on, is placed in the recesses *I* of the milling fixture table *J*, and, on the application of air pressure in the cylinder, motion is transmitted from the plunger, through the intermediate arms, securely clamping the work with jaw points *K* of the clamping arms.



Pneumatic Milling Machine Fixture with Quick Release

The jaws will hold the work thus as long as air pressure is applied, but on its release, they spring back, due to the peculiar construction of the air valve, which, on the air pressure being released, automatically passes air to a pipe running lengthwise of the fixture, in one of the table slots, connecting to the bottom of the plunger, raising it, and thereby releasing the work.

In practice, this fixture has proved very satisfactory, giving excellent service, and with a few modifications, it might readily be adapted to a large range of work.

Designer

REDUCTION OF EXPRESS RATES

Many of Machinery's readers, who are large shippers of goods by express from and to New England points, are not aware of the substantial reduction of express rates recently made.

For about one year Mr. Henderson, of the National Claim Bureau, 170 Broadway, New York City, and myself have been fighting the Adams Express Co. in a suit before the Interstate Commerce Commission, No. 3183, endeavoring to secure lower express rates to and from New England, and by decision recently handed down by that Commission, the Commission has ordered a reduction of 25 per cent on rates to and from New York and Brockton, Whitman, Rockland, Taunton, North Attleboro, Mass., and Pawtucket, R. I.

This rate took effect February 6, 1911. It applies to what

is known as the "Boat and Rail Line," but is rail to Fall River and thence by boat to New York. The rate was formerly $1 per hundred either by rail or water, and now it is 75 cents per hundred; small packages accordingly. To secure this rate it is important that you mark all packages via "boat and rail," otherwise the Adams Express Co. will charge you $1 per hundred. The service is equally as good as all rail, and in some respects better.

This decision is the first break in the express monopoly, and it is of great importance. It would be well to notify all customers to mark goods between the aforesaid points via "boat and rail." RICHARD J. DONOVAN

170 Broadway, New York.

DISABLED DRILL SHANKS AND SOCKETS

In the January, 1911, issue of MACHINERY Mr. Cook describes a method of repairing the tang slots in drill sockets, stating that the advertised remedies for drill troubles refer to damaged tangs only, and overlook or ignore the trouble that arises when the tang slot (or tang seat as some might call it) in the socket is worn out. The writer suspects that some of the manufacturers may take issue with Mr. Cook on

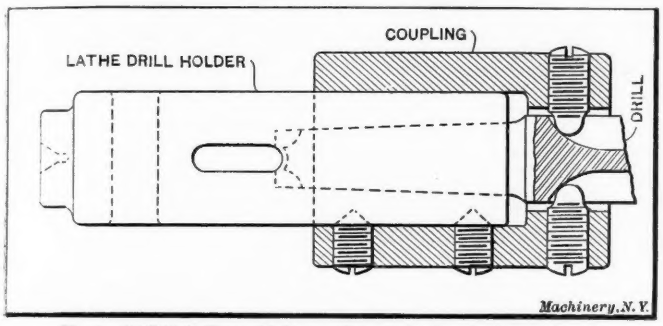
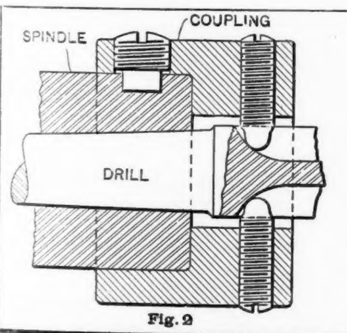


Fig. 1. Drill Coupling which may be used when both Tang and Slot are worn out

this question, as there are sockets on the market which dispense with both the drill tang and the slot with which it engages.

However, if it is not desired to purchase any of the new sockets, one of the home-made drivers or couplings illustrated in Fig. 1 of the accompanying drawings may be made at small expense. This coupling makes it possible to use the old drills and sockets when both tang and slot are worn out.

As shown, the coupling is secured to a lathe drill-holder by



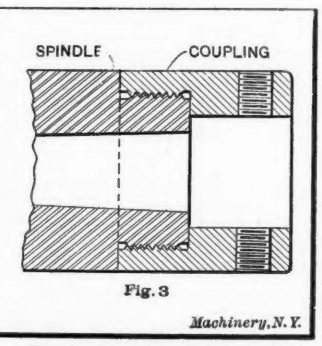


Fig. 2. Coupling applied to Drill Spindle with Short Projecting Edge

Fig. 3. Coupling applied to Drill Spindle which does not project

two V-pointed set-screws, the drill being gripped in the flutes by two round-pointed screws. Obviously the device will answer equally well for a common drill socket. As the old socket is likely to be damaged more or less by hammer marks, it should have a light cut taken over the part where the coupling is to be attached. The coupling should be bored for a tight fit on the socket, but the hole for the drill should be of sufficient size to freely admit the largest drill that the socket will carry. The writer has successfully used this device for ordinary work, but has not tested it in very heavy drilling.

A coupling made on this principle can be used on a drill spindle when the tang slot is worn out. Fig. 2 shows such a coupling, as designed for a certain drill-press which the writer has in mind. In this particular machine the end of the spindle which carries the drill projects only 1⅛ inch below its bearing in the arm when the spindle is raised to its highest position. In such a case one good sized screw might be used as indicated in the sketch, or two screws may be placed "quartering," as some would prefer.

If the construction of the machine is such that the spindle in its highest position does not project at all below the arm, the coupling cannot be larger in diameter than the spindle. In such a case the construction shown in Fig. 3 will answer. Here the coupling is screwed on the spindle, the latter being turned smaller and threaded on the end. Some manufacturers make their drilling machines with thread already on the spindle. A coupling like one of those last described might be kept permanently on the drill spindle, and it might have in addition to the two round-pointed screws, two of some other shape to drive sockets. If the coupling prevented the shank of a drill chuck from entering the full depth in the spindle, a longer shank could be made; and this shank could have an enlarged collar with two grooves or "countersinks" to receive the points of the set-screws which drive the drills.

By way of apology for the old-style drill sockets and drill shanks, it may be said that much of the trouble that has been complained of is due to ignorance and carelessness. When the key is missing, the careless workman uses a hammer to pound the socket out of the spindle and the drill out of the socket. This damages both drill and socket to such an extent that the drill will not go into the socket the full depth, and the tang works at a disadvantage. The drill runs "out of true" also. If now while drilling a defective casting the drill hangs in a "blow hole," the framework of a light machine may "give" sufficiently to cause the socket to lift and "ride" the drill tang. It requires but a few repetitions of such abuse to ruin both the tang and its slot in the socket. The drill should fit the socket so well that it would be driven partly by friction, and the key should be chained to the machine within convenient reach of the workman. Under these conditions the common twist drill will "stand up" fairly well for average work; but it may as well be admitted that the tang is too weak for the heaviest forced drilling and roughest usage. W. S. LEONARD

Atlanta, Ga.

RESTORING OVER-EXPOSED BLUEPRINTS

In the "How and Why" columns of the February number of MACHINERY a method was given for restoring over-exposed blueprints. While the method was all right, the writer would suggest another one which is simple, and can be easily accomplished. This method is accomplished by taking the over-exposed print from the washing tank and while still wet laying it face upward on the table, then placing an unexposed dry piece of blueprint paper of the same size over the wet one, and rubbing it with a piece of cloth or with the hands. This brings the two surfaces into intimate contact, and when separated it will be found that the over-exposed print is perfectly clear and of a rich blue color. The color obtained by this method is better than that obtained by the ordinary exposure and development. There is one objection to this method, which is that a piece of blueprint paper is wasted for each print made. S. M. RANSOME

Cleveland, Ohio.

"PUNCHES AND DIES FOR MAKING A SPRING CLIP"—A CORRECTION

On pages 434-436 of the February number of MACHINERY, engineering edition, was published a description of a set of dies that I designed while working for the Elliott-Fisher Co. I would like to correct the statement that these tools were "in the nature of an experiment." The tools were designed to do the work and there was no experimenting about them whatever. J. CERMAK

Lima, Ohio.

WHAT ARE MACHINE TOOLS?

Machine tools are that *class* of machines, which, when considered as a *group*, can reproduce themselves.

Meriden, Conn. WALTER L. CHENEY

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

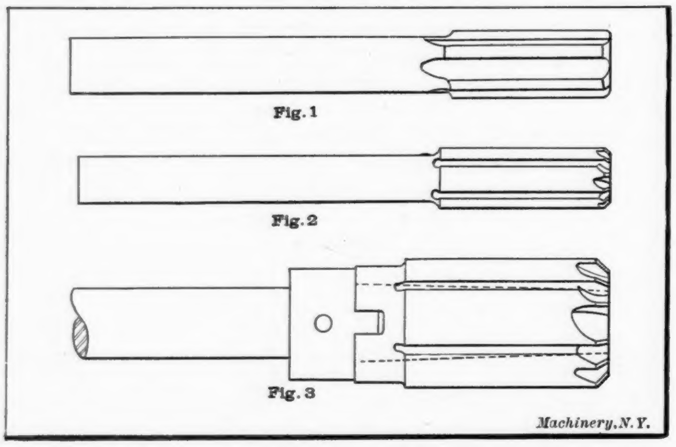
FRICTION DISKS FOR CUTTING SOFT-STEEL SHEETS

G. F. Co.—We have to cut some No. 26 gage, soft-steel sheets with a rotary disk, which is 7⅝ inches in diameter by ⅛ inch thick, and has a 5-inch hole. The disk is to cut the material by friction only. We have tried tool steel, but find it is too brittle and that the disk chips off. We would appreciate any information on this subject.

USE OF FLUTED REAMERS IN JIGS

R. G. B.—A difference of opinion exists as to the possibility of finish reaming machine parts with a fluted reamer, through a hardened steel bushing, without excessive wear on the reamer. Some manufacturers claim that it is not a manufacturing proposition, while others claim that this method is their regular practice. I am interested in the subject, and would appreciate your assistance in procuring the opinion of your readers.

A.—The ordinary fluted reamer shown in Fig. 1 is not the best type to use for machining operations, especially where the reamer is to pass through a hardened bushing. No doubt this reamer is used, however, for this class of work, but it is not the preferable form. The rose reamer shown

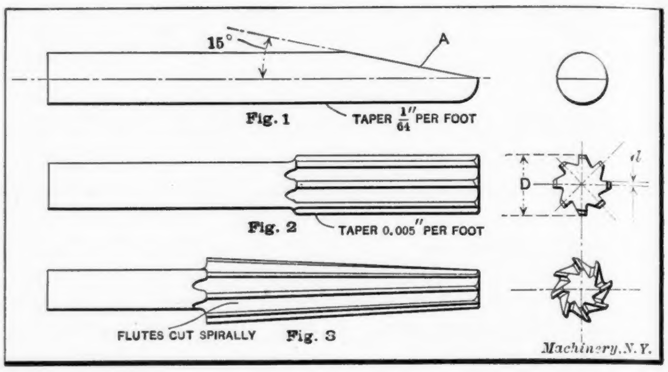


in Fig. 2 is better, and is especially recommended for this class of work. This reamer is fluted on the periphery as shown, but is not backed off, the cutting edges being on the end of the reamer only. The body of the reamer is made tapering towards the back an amount equal to about 0.010 inch per foot. It is obvious that by using a reamer such as shown in Fig. 2, very little, if any, wear will take place on the periphery of the reamer, as it has no cutting edges. Shell rose reamers are used for work over one inch in diameter, and are commonly made as shown in Fig. 3. These reamers are cut on the same principle as the rose reamer shown in Fig. 2, having cutting edges on the front end of the reamer only. The flutes in the body of the reamer are for the purpose of conveying oil to the cutting edges, and also to facilitate the removal of the chips.

REAMERS FOR CUTTING BRASS

R. H.—What is the correct way to make straight or taper reamers for cutting brass? Should the cutting edges of the teeth be on the center, back of it or ahead of the center?

A.—The type of reamer to be used for cutting brass is determined to a considerable extent by the diameter of the reamer and the machine in which the reaming is to be accomplished. For screw machine work the reamer shown in Fig. 1 gives good results, when the diameter of the hole is not greater than ⅜ inch. This reamer is made from a piece of drill rod, hardened, and is tapered slightly toward the back an amount varying from 0.005 to 1/64 inch per foot. It is resharpened by grinding on the face *A*. When the hole to be reamed is greater than ⅜ inch, a reamer of the form shown in Fig. 2 should be used. This reamer is fluted its entire length similar to an ordinary hand reamer and the teeth are backed off. It is preferable, when cutting brass, to locate the cutting edges ahead of the center so that a negative rake will be presented to the work, which produces a scraping cut. The teeth should also be of an uneven number or else staggered to obtain good results. The distance *d* that the cutting edge is ahead of the center should equal $\frac{D}{20}$, where *D* is the diameter of the reamer. For taper reamers where the taper does not exceed 1½ inch per foot the flutes should be cut spirally as



shown in Fig. 3. A left-hand spiral of about one turn in 36 inches is generally used. The cutting edges should also be set ahead of the center the same distance as the reamers shown in Fig. 2. Where the taper is greater than 1½ inch per foot the flutes can be cut straight, but should be serrated so that the chips will be broken up. The serrating is accomplished by gearing the lathe in a similar manner as for cutting a thread. The grooves which are about 1/16 inch deep by 3/32 inch wide are cut with a round-nose tool. About three turns to the inch is generally used for serrating a reamer.

MAKING TOOLS FOR DRILLING, TAPPING AND MILLING COPPER

E.—How should the tools for drilling, tapping and milling copper be made, and what lubricants should be used in the machining processes?

A.—In drilling copper, the angle of the cutting edge and the character of the drill used is determined by the depth of the hole to be drilled. For drilling through thin sheet copper, or for shallow holes, an ordinary twist drill can be used, but this should be ground with a negative rake, and the lips ground in so that the lip of the drill will not have as much clearance as would be necessary for drilling steel or iron. For deep holes, a straight-fluted drill is commonly used. This drill should be lubricated with either soap and water or beeswax, the latter giving excellent results.

It is sometimes recommended, and is generally found to give good results, to cut spiral flutes on taps to be used for copper, and also to have an odd number of flutes. The spiral should be right-hand for a right hand thread and with a lead of about one turn in 12 inches. Beeswax is recommended also as a lubricant for tapping. For cutting the grooves in the tap, a cutter should be used which will not make the cutting surface radial, but which will set it off at an angle of about 15 degrees from the center, thus producing a negative rake.

For milling copper, the teeth of the cutter should not be spaced close together for general conditions, but, of course, there are some cases, for example, the slitting of narrow stock, in which it would be necessary to have them closer together than it would be when cutting thick stock. About ⅛-inch pitch is generally used for slitting saws. The face of the teeth, instead of being radial, as is the usual practice for cutting steel, should be laid off at a tangent to a ⅞- or 1-inch circle, depending on the diameter of the cutter. For milling cutters for surfacing-work, it is best to cut the teeth spirally, a spiral of one turn in seven inches being about right.

There are various cutting compounds used for cutting copper, but either soap and water or beeswax will be found to be the most efficient. Beeswax gives a very smooth finish and has no other objections except that it gums up the machine. It is also said that milk is a good lubricant when cutting copper; tallow will give about the same results as beeswax.

"INS AND OUTS OF GEAR HOBBING"— A REJOINDER

By E. J. LEES*

In his article in the January issue of MACHINERY, "Ins and Outs of Gear Hobbing," Mr. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., has attacked the gear-cutting system commonly known as hobbing, and made some comparisons with gears produced by the Fellows gear shaper, much to the advantage of the latter; therefore we ask Mr. Flanders to answer this one question: Does the sharpening of the cutter used on the Fellows machine change the circular pitch of the cutter? We should very much like a direct answer to this one question. We are not asking about the correct involute or anything else, simply does the process of grinding the Fellows cutter to maintain the cutting edge change the circular pitch of the cutter or not?

Mr. Flanders states that the machine used for his experiments was in his judgment the best designed and most satisfactory machine of all the hobbing machines, and then proceeds to call attention to such vital errors in design as overhang in cutter, restricted bearings for shafts and the use of differentials. The absence of all these points are the particular and some of the principal advantages advanced for the machine we manufacture, to recommend it to the purchasing public. We emphasize the fact that there is no overhang in our cutter (hob), that there are larger and stiffer bearings in our machine than in any other gear cutter made, that we do not use a differential or "jack-in-the-box" and that we have no shafts of length with torsional stress, our longest exposed shaft from bearing to bearing being eight inches. We discussed all this with Mr. Flanders at MACHINERY's last outing in October last, and gave him a circular describing our machine.

We realize that any innovation in any field must expect to encounter every kind of opposition, but is it not a fact that if the gear hobbing process were otherwise than the success it is, our competitors would treat it with silent contempt? We claim that the correct machine and the correct hob will produce correct involute gears of any number of teeth within the range of the common acceptance of the term. We claim that the gears produced are the same no matter how much the cutter is ground for sharpening. We admit that the helical gear is quieter than the spur, but most emphatically assert that it is more correctly cut on a hobbing machine than in any other manner, and deny, as implied by Mr. Flanders, that the hobbing process "puts one over" on the user, simply on account of the fact that the helical gear being so much better than the spur takes care of the faults of the hobbing process. In regard to the explanation of centering the hob, the experiments as given only indicated distortion in the hob used. Otherwise all teeth in a hob, which are supposed to be and should be duplicates, would produce the same results. Here again lack of care is shown in selecting the hob.

Mr. Flanders further asserts that a hob should be helically fluted at right angles to the lead. This we assert is entirely wrong. In the hob which we manufacture the flute, though straight, is still at right angles to the angle of the lead. In a radial spirally-fluted hob the teeth at one end are hooked while at the other end they are stubbed as related to the generating plane.

What has often been mistaken for flats by the average user is caused by the distortion in the hob which prevents correct generation and allows some tooth or teeth to cut where they should generate or, to use a homely expression, one or more of the teeth being out of true, when coming into the generating plane "side swipe" the work and leave a flat surface. Theoretically, there is no question about there being flats on any generated gear, and this applies to bevel as well as spur gears, but *theoretically* it is impossible to mill a flat surface with a cylindrical cutter.

* * *

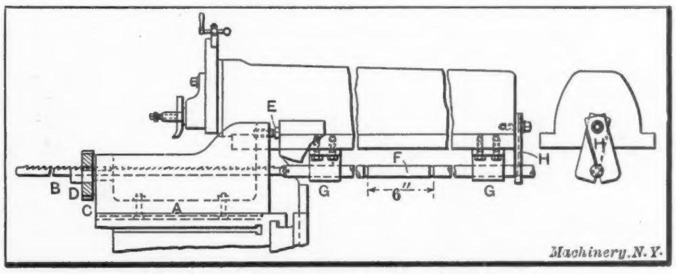
The foreman with the faculty of putting the right man in the right place has the master key to success in handling men.

*President Lees-Bradner Co., Cleveland, Ohio.

BROACHING ON THE SHAPER

Smith & Mills Co., Cincinnati, Ohio, builder of shapers, has made a number of interesting shaper appliances for use in its own shop, to perform operations that ordinarily are done on a gear-cutter, broaching machine, etc. The illustration shows a simple rig, which converts the shaper into a fairly effective draw-cut broaching machine, used for cutting keyways in gears and pulleys.

An open box casting *A*, having a hole bored through the front wall for the slotted mandrel *D* on which the gear *C* is mounted for keyseating, is bolted to the knee. The cutter blade *B*, about four feet long, one inch wide, and of the thickness required by the width of keyways to be cut, is drawn through the gear by successive strokes of the ram. The ram motion is transmitted to the cutter by the notched bar *F* and



Broaching Attachment on Smith & Mills Shaper

the latch *H*. The notches on the bar are 6 inches apart and the stroke of the ram is adjusted to a movement slightly more than six inches, or twelve inches if the cut is not very wide and deep. To pull the cutter four feet on the short stroke which is used for the larger keyways, eight strokes are required, and half as many, of course, when using the twelve-inch stroke.

The thrust on the casting *A* is taken directly by the column through two screws, one of which is shown at *E*. The guides *G*, bolted to the under side of the ram to support the bar *F*, do not interfere with the regular uses of the shaper, and are permanently fastened in place. The latch *H* is simply two pieces of flat steel reduced to half-thickness where they overlap, and pivoted on the top screw on which they freely swing. When the ram moves forward, the leaves swing apart and drop into one of the notches of the bar on the return stroke, when they act the same as a pawl.

This rig on a 21-inch shaper with the stroke reduced to six inches has ample power for any ordinary keyseating required in the making of the Smith & Mills shapers. The keyseats in two steel gears are cut at once.

* * *

DESIGNING A SHAFT

"I have made some careful calculations," said the Chief Draftsman to the "Big Boss," "and I find that if we use a $2\frac{1}{4}$-inch shaft for the main driving shaft in the head of that machine I spoke to you about yesterday, we will have a mighty small factor of safety, but I don't see how we can use a bigger shaft without rearranging the whole design, because there is room for no more and we've got to have some clearance besides."

"Oh, well," said the "Big Boss," "I think that difficulty can be easily overcome. You have a small factor of safety in the shaft already, the way the thing is designed, and as you know, a hollow shaft is stronger than a solid shaft—that being one of the fundamental principles of the strength of materials. Now, the way to fix this matter is to drill a small hole through the shaft and we will have obtained a factor of safety which will undoubtedly give us all that is desired. I am glad you spoke to me about this as, otherwise, you might not have thought of this easy way out of the difficulty and might have gone to considerable trouble redesigning the machine so as to be able to put in a shaft of a larger diameter. It is a mighty good thing, Mr. Smith, to go back once in a while to the text-books and take note of the fundamental principles. I have found that it has helped me over lots of difficulties, for while I am a practical man, I pride myself on having acquired just enough theory so that I can combine the two to advantage."

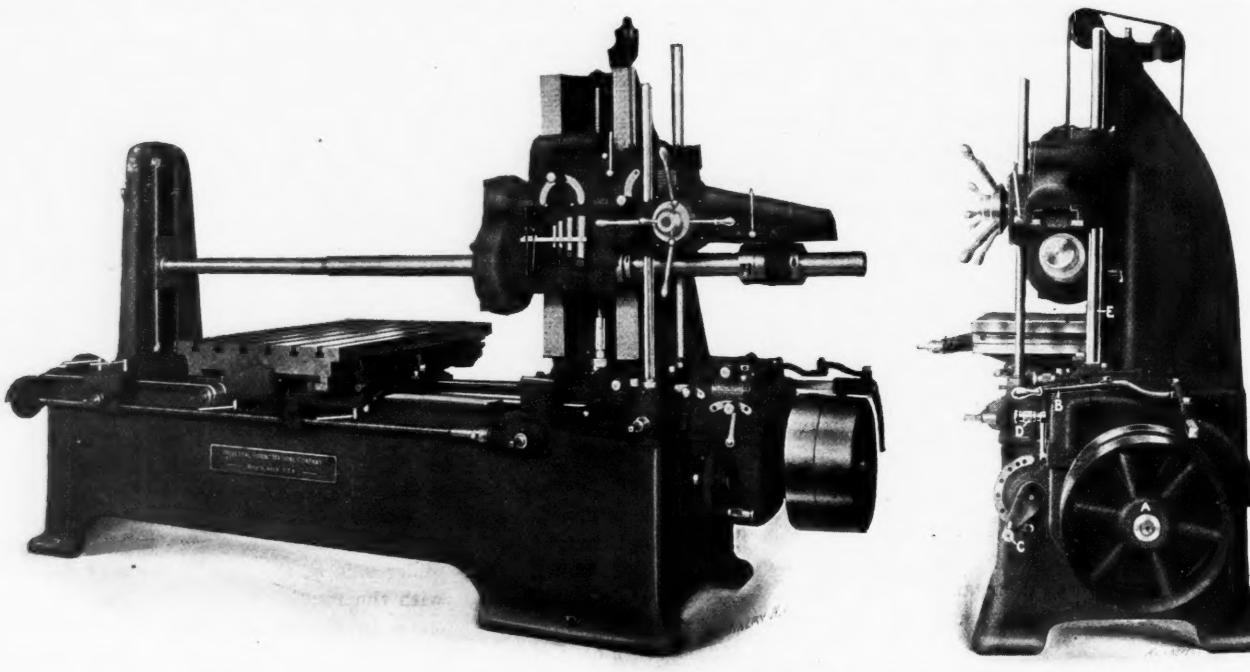
NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

THE UNIVERSAL HORIZONTAL BORING MACHINE

The Universal Boring Machine Co., Hudson, Mass., is now manufacturing the No. 3 size of horizontal boring machine, illustrated in Figs. 1 and 2. The size of this machine expressed in figures is 3 by 30 by 30 inches, the figures indicating the diameter of the boring-bar, its horizontal travel, and vertical feed. The engravings Figs. 1 and 2 illustrate the front and end views of the machine, respectively. As will be noted, this machine is of the constant-speed drive type and it is adapted for either belt or motor drive. The construction is very rigid, the upright which supports the spindle head being of the box form, and the bed and saddle being so constructed as to give a maximum support to the table. In this connection it should also be noted that the saddle has large bearing surfaces on the bed. The location of the operating levers and the handwheel for the rapid adjustment of the boring-bar, and the facilities for changing speeds and feeds, are also noteworthy features.



Figs. 1 and 2. Front and End Views of No. 3 Horizontal Boring Machine, built by the Universal Boring Machine Co.

The Spindle Drive

As the machine is of the single-pulley drive type, the drive may be direct from the main line, the tight-and-loose pulleys being carried on the machine itself. The driving pulley is 18 inches in diameter, 3½ inches wide, and runs at 250 revolutions per minute, which gives a powerful and efficient drive. A conveniently-located shifter-handle, at *B* (Fig. 2), shifts the driving belt. The loose pulley is of single-piece construction and an oil reservoir for supplying its bearing is cast solid around the hub at *A*. The bearing proper has a groove cut in it in which is laid a wick, the ends of which dip into the reservoir below. The drive to the spindle is transmitted from the speed gear-box through the vertical shaft *E* to the head proper. The exterior and interior details of the head are shown in Figs. 3, 4, and 5. The construction of the spindle head is radically different from the No. 2½ machine, (which was described in the department of New Machinery and Tools, September, 1909), the head casting being one single piece, with oil pockets cored out in the casting itself for holding lubricant for the bearings.

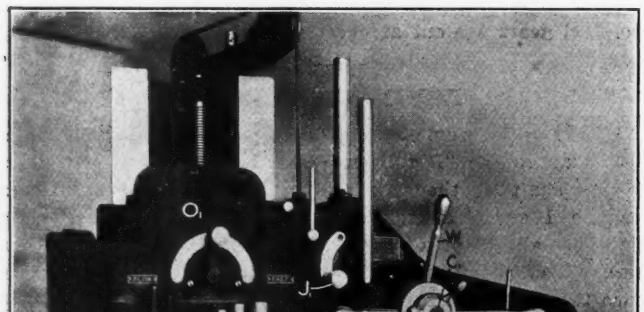


Fig. 3. Detail View of Spindle Head, showing Operating Handles

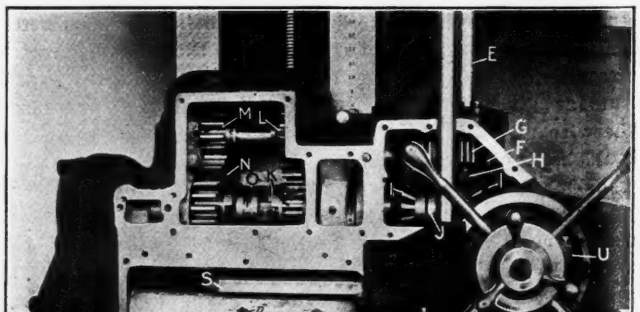


Fig. 4. Spindle Head with Plates removed to expose Mechanism

In Fig. 3 are shown the various operating handles. The handle J_1 reverses the spindle's direction of rotation by operating the jaw clutch J, shown in Fig. 4, and the handle O_1 operates the clutch O, changing the machine from a direct-geared drive to a back-geared drive. As will be seen in Figs. 4 and 5, the power is transmitted from the speed gear-box through the shaft E to the spur gear F, then through G to the bevel gear H. The bevel gears H, I and I_1, together with the clutch J, make up the reversing mechanism. From the reversing mechanism the power is transmitted direct to the driving gear Q, when the clutch O is engaged with K; or around through the gears L and M, when the clutch is engaged with N.

The driving gear is located at a point nearest the work, as shown in Fig. 5, Q being the driving gear and P the driving pinion. This arrangement greatly reduces the torsional strain on the spindle and stiffens it, thus eliminating the chatter usually present when taking heavy milling cuts on machines having the drive at a long distance from the work. The driving gear has a long hub which forms the spindle bearing, and to the spindle are fastened two keys, V and V_1, which drive the boring-bar. The hub of the driving gear forms a faceplate to which a face milling cutter may be fastened, there being four drilled and tapped holes for this purpose. This gives a direct and powerful drive.

The design of the head casting permits the rack S (Fig. 4) to travel the full length of the head, so that the hand-wheel for the quick movement of the boring-bar, can be placed on the head well in towards the face of the spindle, allowing the operator to see the cutters and make adjustments at the same time. A travel of 30 inches at one setting of the adjustable collar T is obtained. The automatic bar feed is received from the feed gear-box through shaft f, which carries a worm meshing with the worm-gear U. On the same shaft with this worm-gear, there is a spur pinion which drives the rack. Referring to Fig. 3, C_1 is a positive clutch which secures handwheel W to the worm-gear.

Automatic Lubrication of the Spindle Head

The details of the automatic lubrication of the spindle head, are well shown in Fig. 5. As this illustration indicates, the head is completely self-oiling. The spindle proper is surrounded by an oil reservoir, the gears run in a bath of oil, and the oil reservoirs for the various bearings are cored out of the casting. The locations of the various oil reservoirs are indicated by the letters, i, j, l, k, m, and n. This system of oiling consists of a wicking laid in a slot milled out of the bearing, the ends of the wicking dipping down into the reservoir below. The large reservoir for the lubrication of the main spindle bearings, is filled at n and drained at o. (See Fig. 4.)

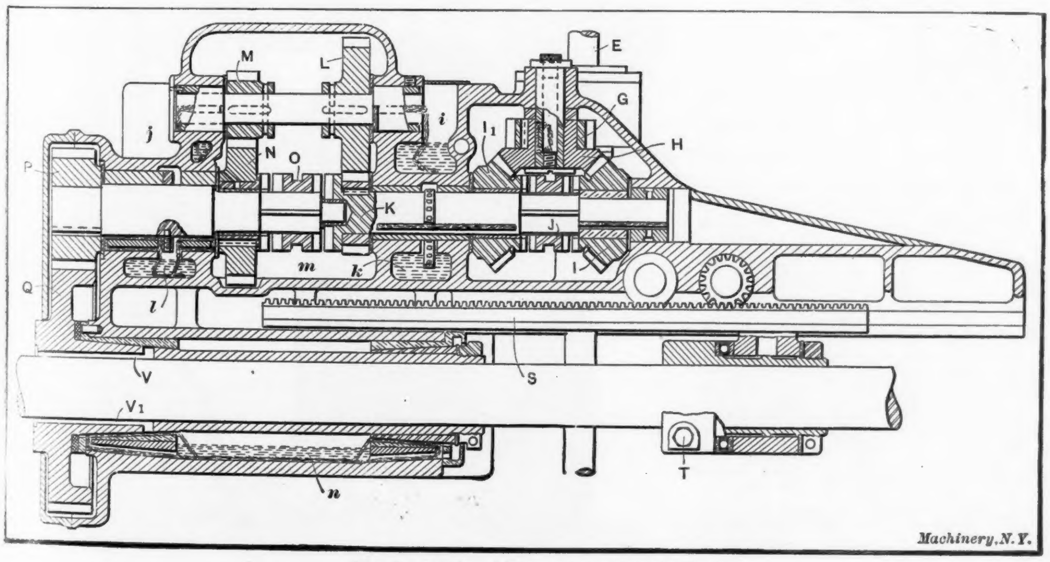


Fig. 5. Sectional View of the Spindle Head

Automatic Feed to the Table

The method of transmitting the automatic feed to the table is shown in Fig. 6. As will be noted, the table has been removed from the saddle, so as to show the details of the feed. The power is transmitted from the feed gear-box through the shaft X which has mounted on it a 45-degree spiral gear meshing with the 45-degree spiral gear Y, and a jaw clutch. The spiral gear runs free on shaft X, and the jaw clutch is keyed with a sliding spline. The spiral gear Y carries the nut for operating the table feed, and when the lever at the right of the saddle is pulled out, as shown, the jaw clutch

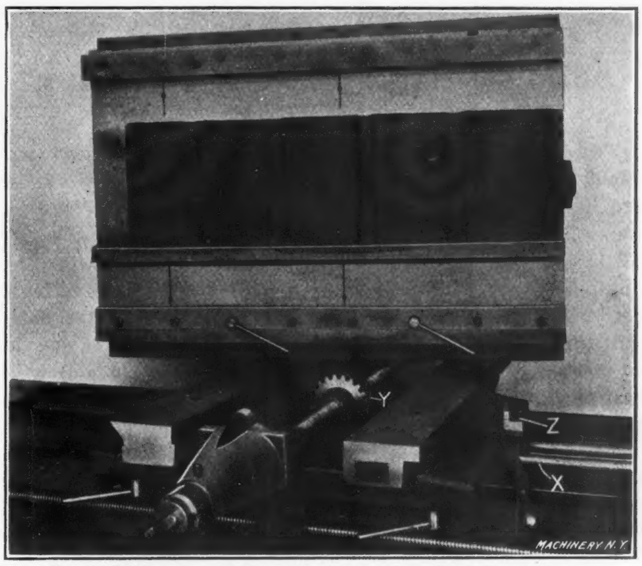


Fig. 6. Table removed from Saddle to show Feed Transmission

engages corresponding teeth in the hub of the spiral gear beneath the saddle, thus engaging the feed. The stop Z is for throwing out the cross feed automatically. The saddle is traversed by power or hand longitudinally along the bed of the machine. A hand crank feed with micrometer adjustment is furnished for the operation of the table longitudinally and transversely.

Speed and Feed Changes

The gear-box is strong and compact, and contains the feed and speed change gears, which are made of steel. These gears run in a bath of oil which insures sufficient lubrication and quiet operation. Eight speed changes are secured from the gear-box by means of levers C and D, Fig. 2, and these are doubled at the head by the back-gear lever, giving a range of from 15 to 200 revolutions per minute. There are nine feed changes in either direction for the head, one lever reversing or stopping all feeds. The feeds range from ¾ inch to 5½ inches per minute, without reference to the speed of the spindle. Fewer changes of speed are required where this system of feed drive is used, as it provides finer feeds for small cutters at high rotative speeds, and coarser feeds for larger cutters at low rotative speeds than can be obtained when the feed is driven from the spindle.

Miscellaneous Features

An automatic vertical milling feed as well as an automatic quick-raising and lowering feed, are provided for the head, in addition to the automatic feed in either direction for the boring-bar and the cross and longitudinal feeds for the work table.

The outer support bearing for the boring-bars, is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing is accomplished by means of a

screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two move simultaneously. Provision has been made for realigning the bearings in case of wear.

This machine has been built with a special view to accuracy and permanence of alignment, and it is particularly adapted to the machining of jigs, crank-cases, cylinders, and similar work requiring accurate boring, milling and drilling operations. The weight of the No. 3 machine is about 10,000 pounds.

DUDGEON HYDRAULIC RAIL BENDER AND PUNCH

Two interesting hydraulic tools that are the product of Richard Dudgeon, Broome and Columbia Sts., New York City, are shown in the accompanying halftones. One of these tools, illustrated in Figs. 1 and 2, is a hydraulic rail bender. This rail bender is provided with double pumps so that both pumps can be used when the work is light, or until the strain becomes excessive, when a quarter-turn of the valve handle will throw out the upper pump and permit the lower one only to operate, which gives the ram a reduced speed and a corresponding increase in power. In this way, a considerable saving in both time and labor is effected.

The ram is fitted with a rack and pinion movement which permits it to be run out rapidly against the rail without the

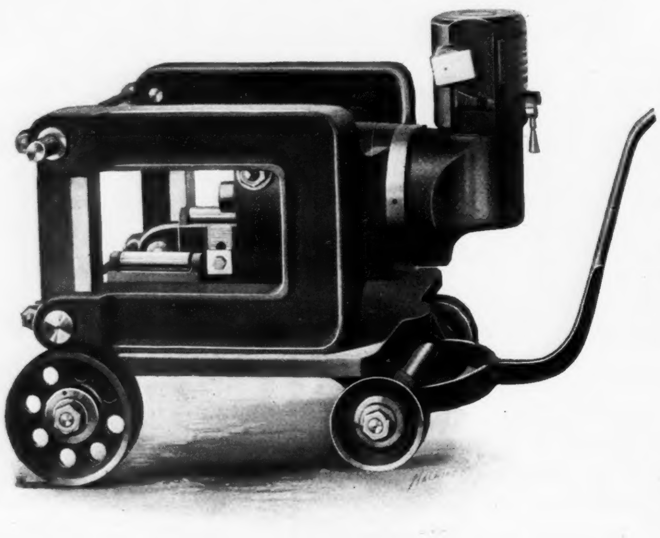


Fig. 1. Dudgeon Hydraulic Rail Bender

labor of pumping, so that the first stroke of the lever is made against pressure, the suction caused by the movement of the plunger filling the cylinder. When the ram is to be returned into the cylinder, the valve handle used in changing the pump from duplex to single, is given an additional quarter-turn, which opens the valves, so that the return of the ram forces the fluid back into the reservoir. The pumping mechanism, shown in the sectional view, Fig. 2, operates on the same principle as that used on the Dudgeon universal jack, which was described in the department of New Machinery and Tools for March, 1910.

Inasmuch as the hydraulic rail bender and the hydraulic punch have always been special tools that used much higher pressures than the hydraulic jack, a man accustomed to the repair of jacks would doubtless have difficulty in repairing these special appliances, as the packings, valves, and joints intended for a pressure of 8000 or 10,000 pounds to the square inch, do not require the same kind of treatment as similar parts subjected to pressures of 15,000 or 17,000 pounds per square inch. These figures represent about the difference in pressure between the hydraulic jack and the rail bender and other forms of tools of the same type. In this new design of rail bender, the pressure is uniformly 6000 pounds to the square inch, which is the same as that used in the universal hydraulic jack. In fact, the rail bender is an adaptation of the universal jack, as before stated, and it is made, where possible, of jack parts; therefore, a railroad having a stock of jack repair parts can use them on the rail benders, and men accustomed to repairing hydraulic jacks can operate and repair this type of rail bender equally well.

To facilitate repair work, the valves, pistons, and pumps have been made as simple as possible. The valves can all be removed by unscrewing one bonnet, and unscrewing a plate permits of taking out the piston. If injury to the pump itself requires its removal, this may be effected by unscrewing

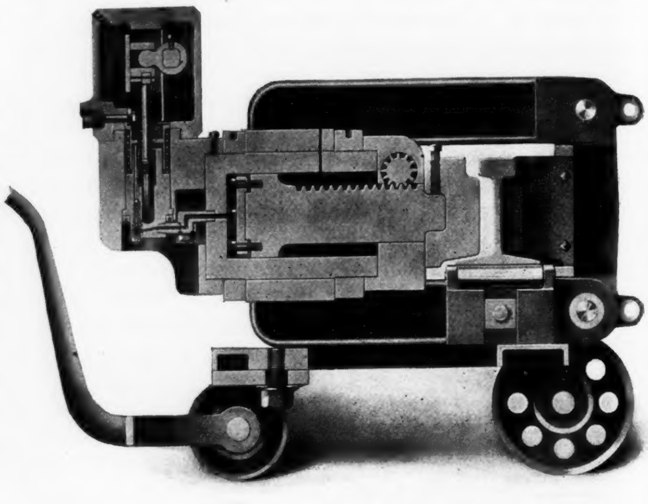


Fig. 2. Sectional View of the Rail Bender

a nut and threaded ring. Owing to the difficulty of machining the interior of the cylinder when formed integrally with the frame, it has also been made removable, the unscrewing of a threaded collar permitting it to be taken out for machining, when necessary.

In Fig. 3 is shown a portable hydraulic punch. This punch also has the rack-and-pinion adjustment for the ram, the double pump giving two speeds, and other features common to the rail bender. It is built in two sizes, the smaller of which has a capacity for I-beams ranging from 6 to 12 inches, and

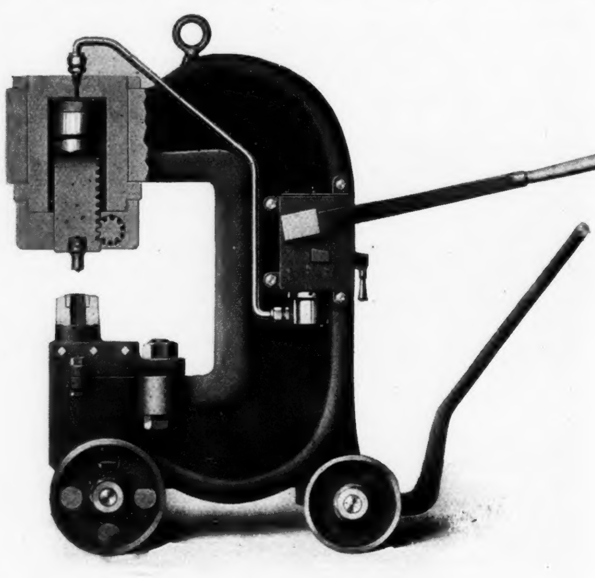


Fig. 3. Dudgeon Hydraulic Punch

the larger for I-beams from 6 to 24 inches. The punch and die are, of course, removable to permit the use of different sizes.

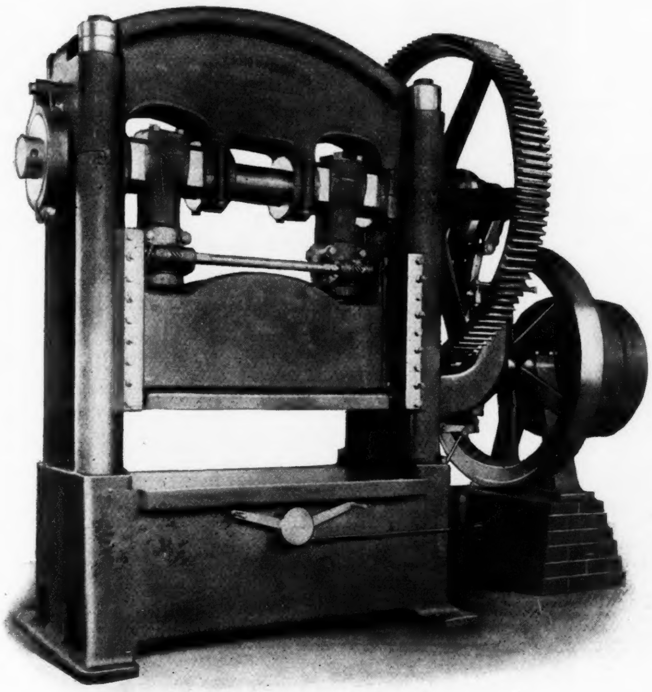
MAX AMS MACHINE CO.'S DOUBLE-CRANK PRESS

The accompanying illustration shows the construction of a line of heavy double-crank presses that is now being built by the Max Ams Machine Co., Mt. Vernon, N. Y. These presses are especially designed for heavy stamping operations, such

as blanking and forming automobile parts, stair risers, ceilings, metal shingles, etc. The parts of the machine have been so proportioned as to gain the best results with the least weight possible. The frame is of the built-up type and is reinforced by four steel rods which take the entire working strain. The slide is well gibbed and it has a parallel adjusting mechanism for raising and lowering. The shaft is large in diameter, to avoid springing, and has large adjustable bearings. The gears are cut from the solid and the driving pinion is made from steel. The clutch is of the sliding block type which is particularly adapted for heavy duty. The striking surfaces are lined with hardened steel faces, and in order to eliminate wear on these faces, the sliding block is pushed away from the wheel sufficiently to give a clearance space.

The press illustrated has a safety device which is especially recommended by the builders. This device has two operating levers, both of which must be grasped by the workman when starting the press. With this arrangement it is impossible for the operator to place his hands between the punch and die while the press is in action. If two men are required to handle the work, four safety levers can be provided. These levers are arranged so that they may be disconnected if necessary.

The principal dimensions are as follows: Width between the uprights, 60 inches; stroke of the slide, 3 inches; distance between the bed and slide when the latter is down and the adjustment up, 10 inches; dimensions of flywheel, 60 by 6½ inches; weight of flywheel, 1700 pounds; diameter and width



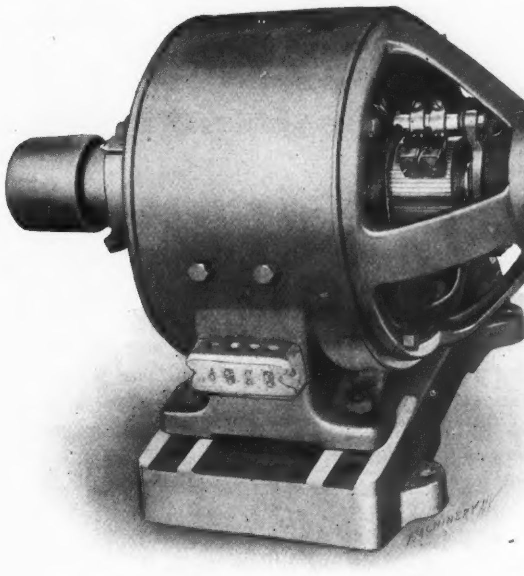
Ams Double-crank Press for Heavy Stamping Operations

of driving pulley, 36 by 8 inches; ratio of gearing, 1 to 9 1/3; and approximate weight, 40,000 pounds.

GENERAL ELECTRIC COMMUTATING-POLE MOTOR

The severe service required of electric motors in many industrial power applications, and the consequent necessity for reliability and efficient operation, requires the use of machines possessing good commutation, overload and heating characteristics, combined with mechanical ruggedness. The type CVC commutating-pole motor brought out by the General Electric Co., Schenectady, N. Y., has been specifically designed to meet such requirements.

Sparking under the brush of a non-commutating-pole direct-current machine is almost wholly due to the absence of a magnetic field, automatic in action and of sufficient intensity to reverse the armature coils, successively short-circuited as corresponding segments pass under the brushes. The commutating poles of CVC motors are connected in series with one another, and also with the armature; their magnetizing power is, therefore, in proportion to the armature current, and consequently, may be employed to compensate for armature reaction, allowing sparkless commutation over wide ranges of load and under adverse conditions of operation. In addition, commutating-pole motors allow a wider range of speed control by field, than is permitted with motors of non-commutating-pole design. The freedom from sparking reduces the heating of the commutator and brushes, minimizes atten-



General Electric Commutating-pole Motor

tion and repairs, and greatly increases the life of these parts.

Internal ventilation is secured by a simple and durable form of fan mounted on the armature shaft within the pulley end bearing head. This fan, while consuming a negligible amount of energy, insures cool operation under severe conditions of temperature and load. The main field coils are wound on strong horn fiber spools, amply insulated with pressboard, mica, varnished cambric, etc., to insure freedom from breakdown under possible excessive potential strains. The windings are rendered moisture-proof by thorough impregnation with a special insulating compound. Before final assembly, the coils are armor-wound with a single layer of enamel-covered wire, which serves the double purpose of protecting the active windings from mechanical injury and assisting to a higher degree of heat radiation.

The commutating poles are wound with rectangular copper wire, the coils being assembled on horn fiber spools, which thoroughly insulate the coils from the pole pieces. Special pains have been taken to so design the commutator that complete immunity will exist from loose or "high" bars. The commutator bars are insulated from one another and from the commutator shell by selected sheet mica, micrometer gaged to a uniform thickness, and of proper hardness to wear down evenly with the copper. The outer corners of the segments are rounded to prevent chipping of the mica, and the inner edges are notched out to prevent short-circuiting between the bars. There are small grooves in both the flat sides of the copper segments which serve, when the commutator is hydraulically pressed in its assembly ring, to firmly anchor the mica insulating segments, thus avoiding the possibility of "high" mica.

As the bearing heads are interchangeable, the relation of the terminal block to the commutator and pulley end heads, may be shifted by removing the heads, turning the armature end for end, and finally replacing the heads to correspond with the reversed armature position. It is thus possible to have the terminal block accessible under varying conditions of installation.

The bearing linings are large, and thorough lubrication is insured by the use of heavy oil rings of generous cross-section. All bearing brackets and frames are drilled and tapped

symmetrically so that the motors may be readily arranged for side-wall or ceiling suspension by turning the bearing heads 90 or 180 degrees, respectively, with relation to the frame.

DAVIS 26-INCH TURRET LATHE

The accompanying halftone, Fig. 1, shows an improved design of turret machine for boring, forming, and turning, that has been brought out by The W. P. Davis Machine Co., Rochester, N. Y. The driving mechanism of this machine has been rearranged, a gear box similar in construction to those used on engine lathes has been added, thus giving a wide range of feeds for turning and thread cutting without the use of change gears, and a number of other changes have been embodied in the new design.

The machine has a geared friction head and triple back-gears so arranged that the triple gear can be meshed directly with the faceplate, if desired. The spindle is made of a special grade of steel, and it has a heavy 18-inch, four-jaw independent chuck. The boxes have ample oiling facilities and are made of the best quality babbitt metal, which is compressed before being bored. The cone has four steps which, in connection with a two-speed countershaft and the back-gears, gives a wide range of speeds. The addition of a change gear box permits changes for turning or threading to be quickly obtained. There are thirty-two changes possible, enabling threads from 2 to 32 per inch to be cut. The position of the feed control levers are plainly shown by an index plate that is simply arranged. Special or fractional threads can also be cut by changing the end gears.

The method of transmitting the feeding movement from the spindle to the gear box is shown in the detailed view, Fig. 2. Shaft *A*, which is driven from the spindle through spur gears as shown, drives shaft *B* which transmits the movement to shaft *G* and the gear box. This box contains a cone of eight gears giving a similar number of feed changes by shifting a tumbler gear, and this number is doubled by engaging key *E* with one of the two gear combinations shown. By reversing the gears between *B* and *G*, a total of thirty-two feed variations is secured. It should be explained that three of the eight cone gears were omitted on the drawing to show more clearly the reversing mechanism. If it is desired to reverse the feed either when turning or thread cutting, this may be done by operating the foot treadle shown at the front of the machine. This treadle controls the location of a clutch that is interposed between the bevel gears *C* and *D*. When this clutch is shifted to the right, into engagement with gear *C*, the drive to shaft *B* is direct, but when the clutch is thrown to the left into engagement with gear *D*, motion is transmitted from *C* to *D* through idler gear *F*, thus giving a reverse movement.

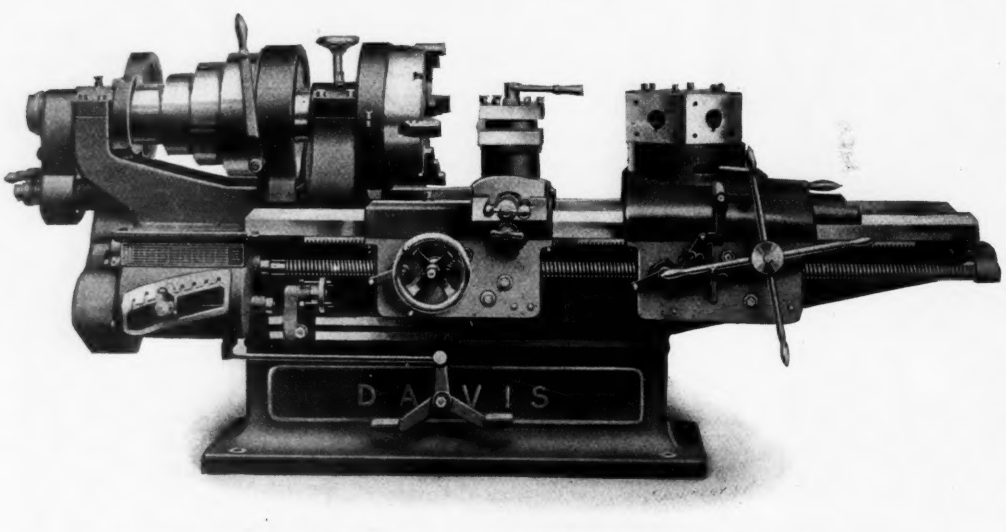


Fig. 1. Davis 26-inch Turret Boring, Forming and Turning Lathe

The turret has automatic stops for each of its six positions, that are located on the bed and are adjustable at any point desired within the length of the bed. Each of the turret faces measures 6 by 8½ inches and is provided with a 2½-inch hole having a keyseat and key to prevent boring-bars from rotating. There are also four small holes for attaching forming tools. A locking device is provided for holding the various faces in alignment with the spindle, and the turret has an open center so that a mandrel can be passed through it. The saddle on which the turret is mounted has a bearing of 30 inches on the

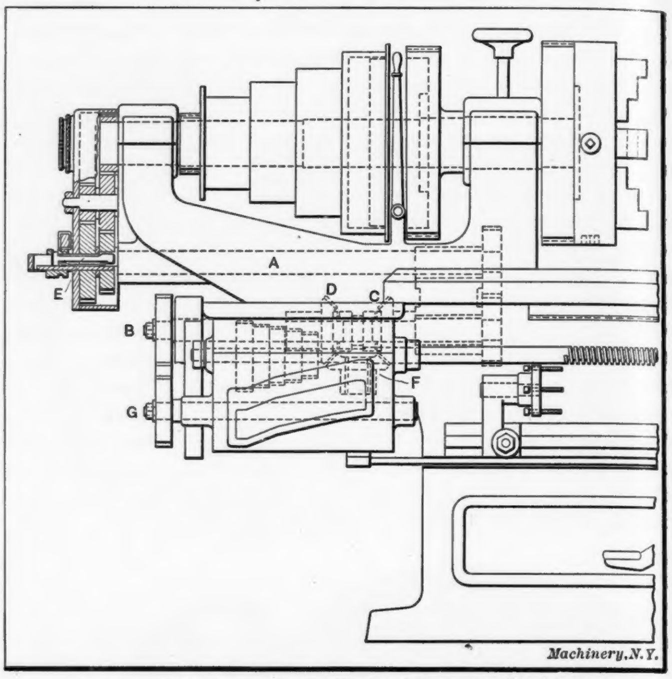


Fig. 2. Detail showing the Feeding and Reversing Mechanism

bed, and a travel of 40 inches. In addition to the sixteen instantaneous and reversible feed changes, the turret has a hand feed operated by the pilot wheel shown. The carriage also has hand and power feeds with automatic stops for the longitudinal feeding movement. A four-sided turret type of toolpost is mounted on the cross-slide and is supplied with a power cross-feed. This toolpost can, of course, be revolved so that four different tools can be used without changing. The carriage and also the turret saddle are driven by the lead-screw, so that either of them may be used for thread cutting.

Some of the general dimensions of this machine are as follows: Diameter of hole through the spindle, 3⅛ inches; size of front spindle bearing, 4⅞ by 7 inches; size of back bearing, 4¼ by 5¼ inches; swing over the carriage, 18 inches; swing over the ways, 26 inches; maximum opening between face of chuck and turret, 50¼ inches; width of the driving belt, 4 inches; net weight, 7000 pounds. The countershaft for this machine has two dust-proof friction pulleys which are self-oiling. The hangers are also self-oiling. The machine can be furnished, if desired, with an oil pan and pump for lubricant.

MOTOR CONTROLLING APPARATUS

The Electric Controller & Mfg. Co., of Cleveland, Ohio, has developed a magnetic switch for controlling the acceleration of electric motors, that is inexpensive and free from complication. As this switch will automatically close its contacts when the motor current falls below a predetermined value, it is a combined magnetic switch and current-limiting relay. The switch has an operating coil which is connected in series with the motor to be started, this coil being composed of a

few turns of heavy wire of fireproof insulation. If the motor current exceeds a predetermined value, the switch will lock out and will not close until the current has been reduced by the speeding up of the motor. A train of these switches, cutting out starting resistance step by step, provides a method of motor acceleration which is absolutely automatic and protective, and it accomplishes this with apparatus so simple that the expense will not prohibit its application to any electric motor.

The front and side views of this magnetic switch (which is known as the type A) are shown in Fig. 1. The operating coil is enclosed and protected by a cylindrical iron shell mounted on a slate panel. At the top are two copper laminated brushes which, when the switch operates, are short circuited, thereby cutting out a section of resistance. At the bottom of the coil shell a movable plug is provided for adjusting the amount to which the current must fall before the switch operates; screwing in this plug will increase the lock-out value, and, of course, screwing it out will reduce the value of the lock-out current.

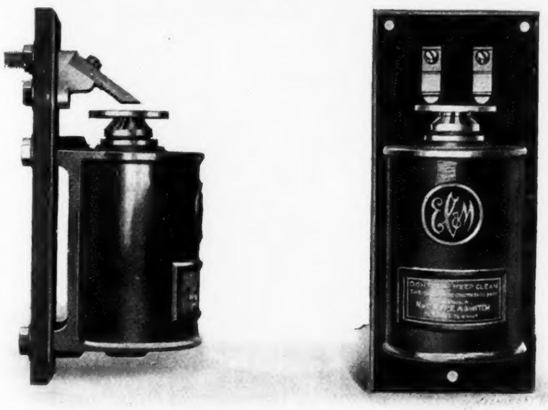


Fig. 1. Magnetic Switch which is used in the Automatic Motor Starters developed by the Electric Controller & Mfg. Co.

Fig. 2 shows the operating characteristics of this switch. In this illustration, the vertical distances represent current flowing through the operating coil, and the horizontal distances, positions of the adjusting plug. The shaded area indicates the operating limits of the switch. For example, if the plug is at position *a*, the switch will lock out at any current above 200 amperes but will definitely close as soon as the current falls to 200 amperes. Similarly, with the plug at position *b*, the switch will lock out at any current value above 300 amperes, but will operate when the current falls to 300

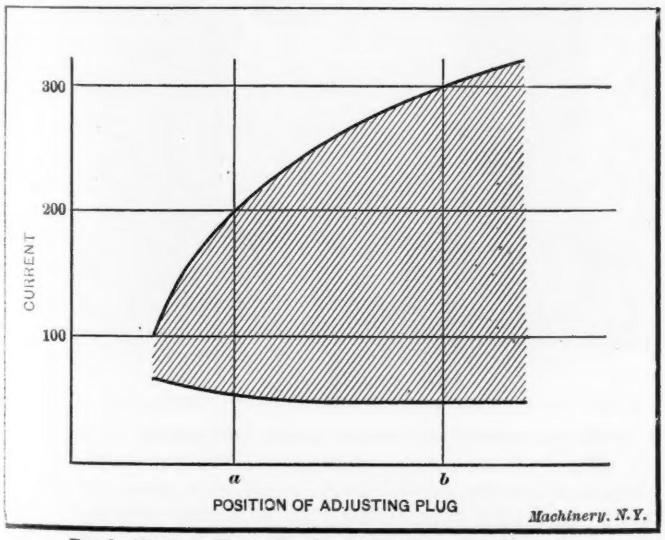


Fig. 2. Diagram illustrating Operating Characteristics of the Magnetic Switch

amperes. The bottom of the shaded area indicates the minimum current at which the switch is operative although, after the switch has once closed, it will remain closed until the current has dropped to practically zero.

A complete line of motor starters embodying the use of this switch, which are known as the E. C. & M. automatic motor starters, has been developed. These have been standardized for 110, 220 and 550 volts (direct current) and cover a wide range of horsepowers. In order to make them as universally applicable as possible, the starters have been laid out in six different forms and, in addition, with various numbers of the accelerating switches. The simplest form consists of a train of type A switches, suitably mounted in connection with resistance, a front view of such a starter being shown in Fig. 3.

Fig. 3. Simple Form of Automatic Motor Starter

This starter is intended to be used in connection with a knife switch, exterior to it. If it is desired to incorporate the knife switch in the starting panel, this is done as illustrated in Fig. 4. Where push-button or automatic control is desired, a shunt wound magnetically-operated switch is also incorporated; this is also preferable for large motors. The starter,

Fig. 4. Panel containing Magnetic Switches and Knife Switch

including the magnetic switch, can also be equipped with an overload, giving complete circuit-breaker features and either of these modifications can be furnished with or without knife switches. A complete line of accessories has also been developed such, for instance, as would be required for automatic pressure regulation, maintenance of water level in water tanks, etc.

The number of accelerating points which any particular starter will develop, is one more than the number of accelerating switches used. For small motors where the load to be accelerated is light, one or two type A switches will be ample; on the other hand, for large motors, and particularly motors which have to accelerate heavy inertia loads, five or six type A switches should be selected. This starter in its simplest form provides no-voltage protection, for if the voltage fails, all of the switches at once drop out, inserting all of the starting resistance in series with the motor; upon the return of voltage, the motor is automatically accelerated in the normal method. To start or stop the motor, it is merely necessary to close or open the knife switch. The acceleration is entirely automatic and will be accomplished in the shortest, safe time. If the load is light, the switches will close rapidly and bring the motor up to full speed in a short period

of time, and if the load is heavy, the switches will close much more slowly and the time required to bring the motor to full speed will be considerably lengthened.

This type of switch also finds a large application in controller work, and the company is prepared to furnish it in connection with either reversing or non-reversing controllers for motors of practically any horsepower and of the common voltages.

NO. 5 ROCKFORD MILLING MACHINE

The Rockford Milling Machine Co., Rockford, Ill., is now manufacturing the design of milling machine illustrated in Fig. 1. This particular view shows the machine equipped with a vertical milling attachment, while Fig. 2 shows the application of a slotting attachment. Both of these attachments are driven by a sleeve or quill, which is connected with the main spindle through spur gearing. This quill is inserted

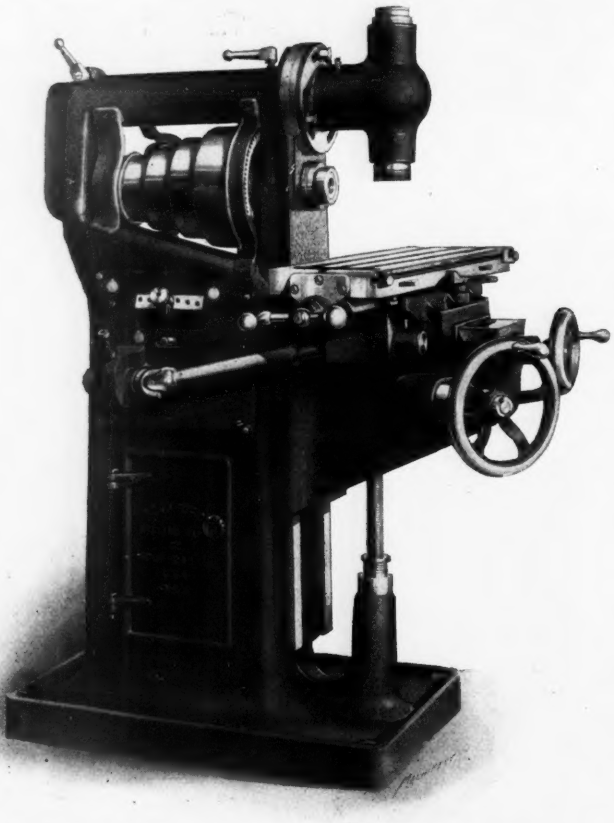


Fig. 1. Rockford Milling Machine with Vertical Milling Attachment

from the back, and it is clamped in place by the same screw which tightens the overhanging arm. When the machine is to be used for regular milling operations, the driving quill may be quickly removed and replaced by the overhanging arm. As the engravings show, these attachments have large bases which are bolted to the column, and the elongated bolt holes provide means for angular adjustment, the angle being indicated by suitable graduations.

This machine has a four-step cone and double back-gears, giving sixteen changes of spindle speed. There are fourteen feed changes ranging from 0.005 inch to 0.210 inch per revolution of the spindle. These changes are effected by handles located on the left side of the column, as shown, one of which gives seven variations through a tumbler gear mechanism, which number is doubled by the interposition of back-gears. The maximum longitudinal feed for the table is 24 inches; the transverse travel is 7½ inches; and the vertical movement below the center, 19 inches.

The principal dimensions of this machine are as follows: Working surface of table, 32 by 9 inches; over-all dimensions of table, 38 by 9 inches; dimensions of the vise jaws, 1½ by 6 inches; maximum opening of jaws, 3¼ inches; diameter of overhanging arm, 3½ inches; distance from center of spindle to overhanging arm, 5¼ inches; width of driving belt, 2½ inches; length of front spindle bearing, 4 inches; diameter of hole through spindle, ⅞ inch; taper of hole in spindle, B. & S. No. 10; net weight of machine and attachments, 1760 pounds. The equipment includes a two-speed countershaft, the necessary wrenches, a vise, and a flanged support for the overhanging arm. In the design of this machine, the aim of

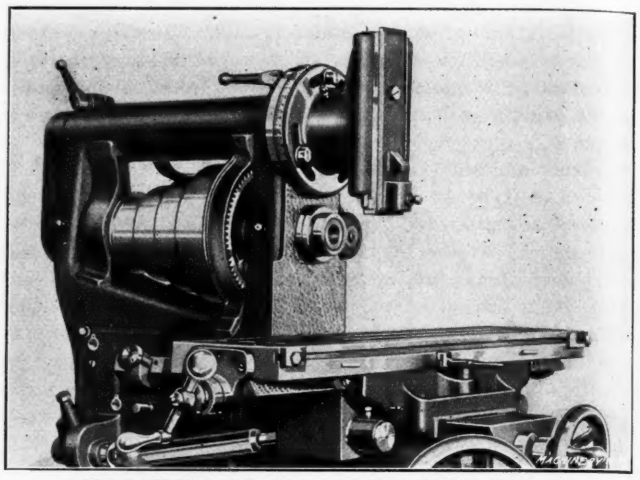
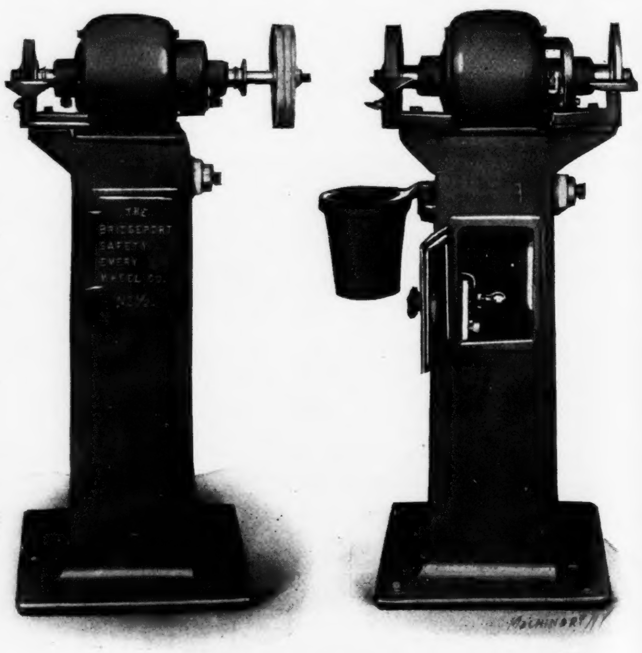


Fig. 2. Slotting Attachment applied to Milling Machine

the builders has been to produce a high-class tool, combining strength with mechanical advantages.

BRIDGEPORT MOTOR-DRIVEN GRINDER

A design of electrically-driven grinder that is now being built by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., is shown herewith. This machine can be arranged with a grinding wheel on each end, or, if desired, one or both of these wheels can be removed and replaced by extra heads that screw on the spindle for holding cotton buffs, felt wheels, wire brushes for cleaning and various other attachments that might be made to screw on in the same manner as the cotton buffs. This machine, as arranged, is for dry grinding, and it is adapted to a variety of work such as drills, lathe and planer tools, chisels and general grinding on small castings and



Bridgeport No. 1/2 Motor-driven Grinder

wrought-iron parts. If there is any probability of drawing the temper of tools when grinding, a water pot can be arranged on the side of the base as shown in the view to the right. The motor is stopped by a snap switch attached to the side of the column, and the starting rheostat is within the column and is reached by opening the door, as shown to the right. These machines are provided with direct-current motors for different voltages or motors of the alternating type as may be desired. The distance between the grinding wheels is 17 inches, the height from the floor to the center of the spindle is 40 inches, and the weight, 350 pounds. The grinder can be provided with an attachment for grinding twist drills if desired.

BATH IMPROVED DUPLEX INTERNAL GRINDERS

A number of improved features have recently been incorporated in the internal grinding machines built by the Bath Grinder Co., Fitchburg, Mass. A No. 2½ size of duplex internal grinder is shown in Fig. 1. This machine has a single spindle-head which carries two grinding spindles that are driven by one belt. These spindles project on each side of the head and operate simultaneously on the work held in the

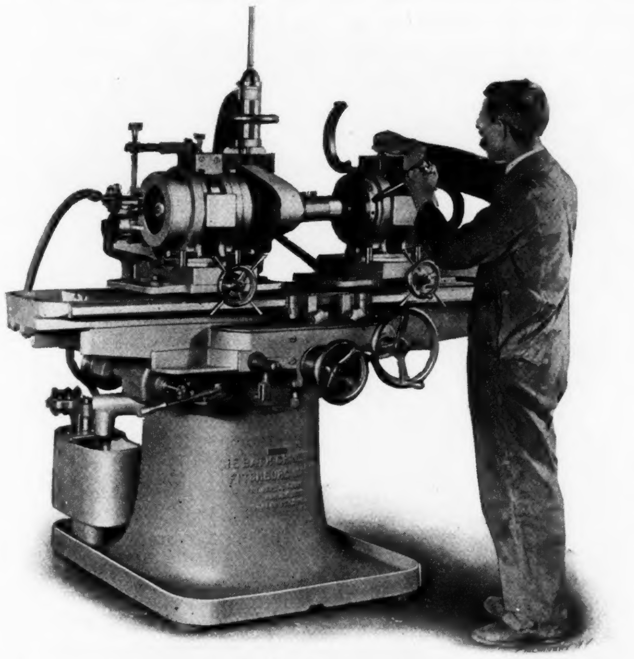


Fig. 1. No. 2 1-2 Duplex Internal Grinder, built by the Bath Grinder Co.

headstocks shown. Both headstocks are mounted on cross-slides that are adjusted transversely by the small pilot hand-wheels shown. Dials on these cross screws indicate the size of the holes on similar parts, by the coincidence of two zero marks, which prevents mistakes. The method of tightening a collet or other work-holding fixture, is illustrated in connection with the right-hand headstock. One half the cover

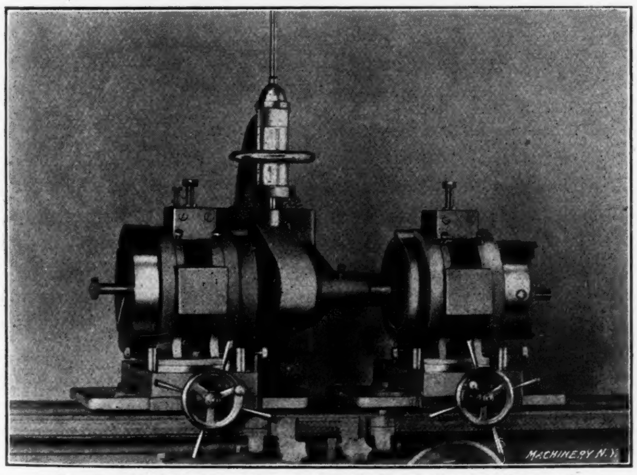


Fig. 2. Headstocks on No. 2 1/2 Grinder, with Faceplate and Universal Chuck

flange (which forms a part of the water shield) is swung upward, as shown, and while the end collar is tightened, the work-head is prevented from rotating by a spring-pin which is temporarily engaged with a hole in its periphery.

Fig. 2 shows the No. 2½ machine with a faceplate mounted on one headstock and a universal chuck on the other, with the grinding spindles entering from the back end, and in Fig. 3 the headstock is seen reversed, to enable grinding from the front end of the hole instead of the back end.

Fig. 4 is a partial view of the No. 5 duplex grinder and illustrates an improved design of headstock for internal work. This headstock is of the swiveling type, which enables straight or taper holes to be ground, and it is provided with water shields or guards for wet grinding. The water pipe is connected directly to the cover, as shown more clearly in the detail view, Fig. 6, connection being made by a flexible hose. When the cover is swung open for truing the wheel or for the insertion or removal of work, the water is shut off by the movement, so that no time is wasted.

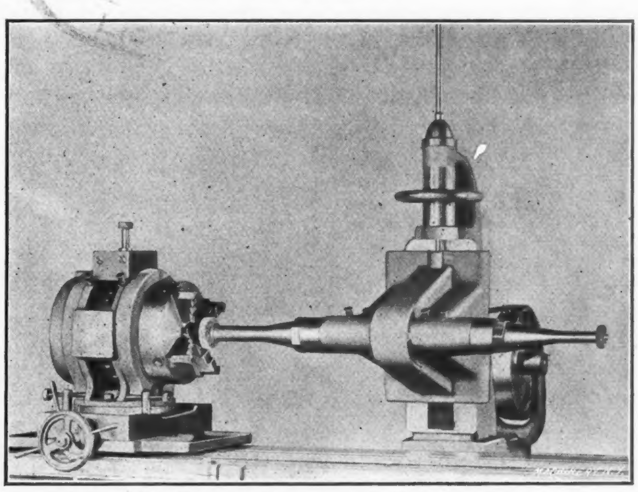


Fig. 3. Headstock Reversed for Grinding from Front End of Hole

A detailed description covering the general construction of the No. 5 duplex grinder, appeared in the department of New Machinery and Tools, October, 1909. A number of improvements have recently been embodied in this machine, among

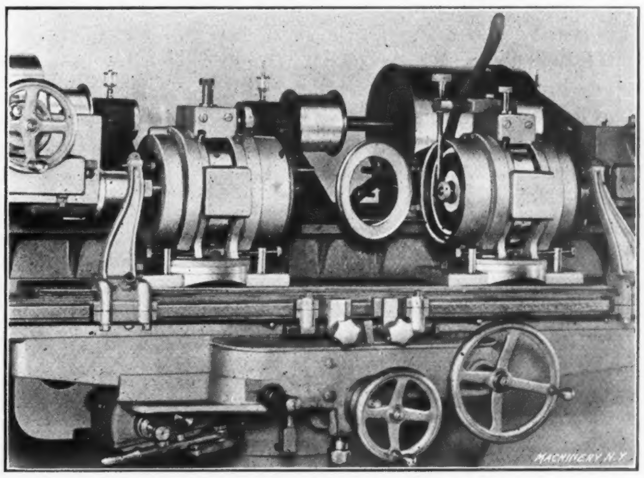


Fig. 4. Detail View of No. 5 Duplex Grinder

which may be mentioned the long reciprocating slide which has been widened and provided with large channels for the cooling water. Another noteworthy improvement is the design of reverse dog for the slide. The end of the dog which

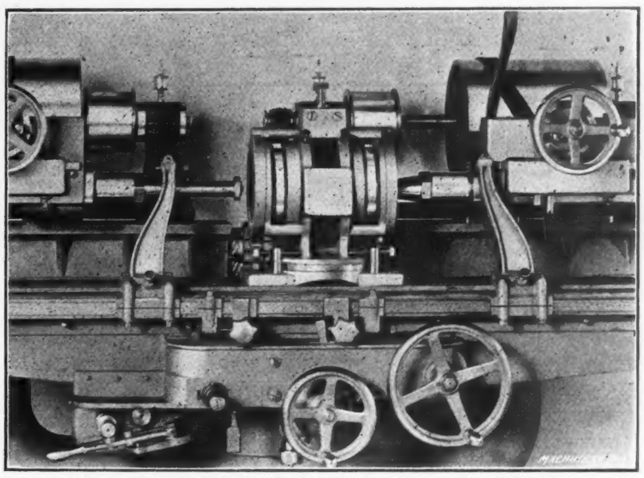


Fig. 5. Special Headstock for Holding Pneumatic Hammers, Long Bushings, etc.

comes in contact with the reversing lever, has three cam-like fingers of unequal lengths, one being long, one medium, and one short. When the dog is turned by the star handwheel so that the long finger strikes the reversing lever (as shown in

the illustration), the wheel is kept in the hole being ground, whereas the finger of medium length allows it to pass half way out of the hole, and the short one lets it entirely out. The advantage of this arrangement is that the stroke of the grinder can be set to keep the wheel at work continuously, that is, in the hole all the time, but whenever it is desired to lengthen the stroke slightly, this may be done by simply turning the dog to bring the short finger into contact with the reversing lever.

Fig. 5 is another detailed view showing the No. 5 machine

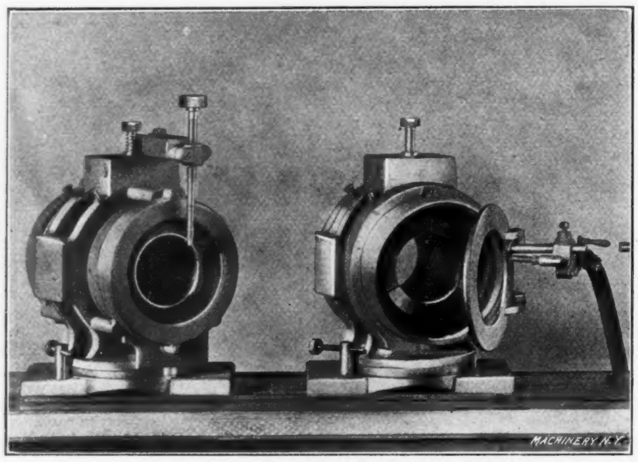


Fig. 6. Improved Headstock with Water Shields

equipped with a special headstock that is furnished for grinding pneumatic hammers, long bushings, etc. With this type of headstock, a coarse grinding wheel may be used for roughing the hole and a fine one for finishing, or two end bearings may be ground simultaneously.

The grinding spindles used on these machines have a large body of metal at the back end which absorbs the vibration of the nigh-speed grinding spindle, and also the heat generated

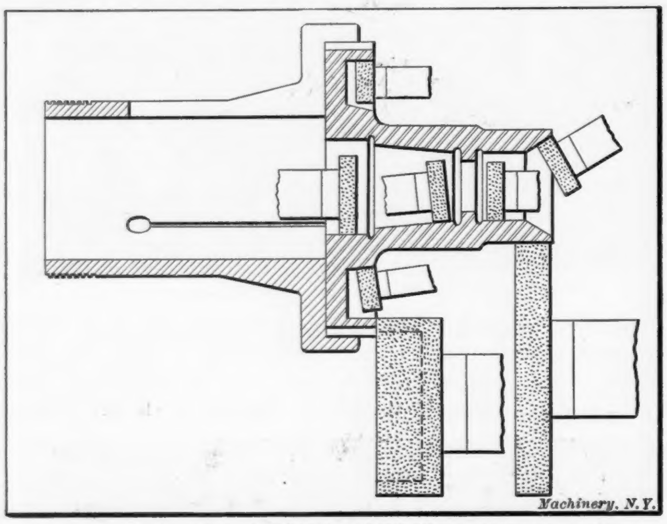


Fig. 7. Internal and External Grinding on a Gear

at the small end of the spindle, thus permitting higher speeds. The bearings are made from Tobin bronze, and the grinding spindles are hardened, ground and lapped. There are no oil holes in the body of the spindles, lubricant being admitted from the back end, which makes a dust-proof construction and allows the machine to be oiled without changing its position.

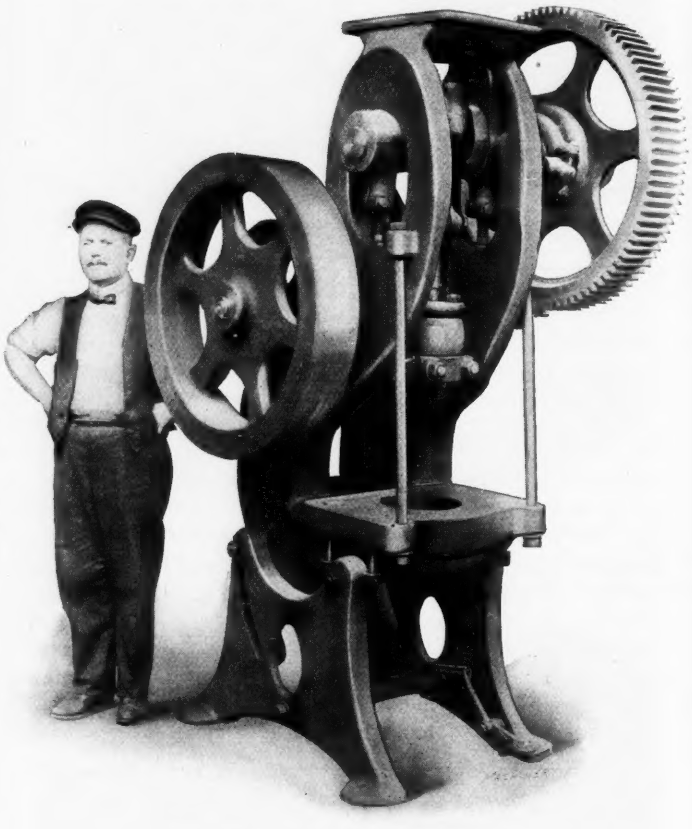
An interesting application of the duplex type of grinder to the finishing of a gear that is part of the dividing mechanism of a gear-hobbing machine, is illustrated in Fig. 7. As the engraving shows, the work is ground internally, from the back and from the front at the same time, and externally on the periphery and side.

FERRACUTE ELECTRICALLY-DRIVEN PRESS

The increasing use of electric power for driving machinery, naturally necessitates changes in the design of the driven machines to provide for the proper application of the power.

The Ferracute Machine Co., of Bridgeton, N. J., has just built a form of press that is particularly adapted for an electric motor drive. A prominent feature of this press is the enlargement of the upper part of the frame so as to provide a base or shelf on which to bolt the motor. This feature is apparent in the accompanying illustration, which shows a DG4 press with a somewhat heavier flywheel than usual, occasioned by the requirement that the press should run at a comparatively slow speed.

The flywheel may be bolted direct to the motor, or, as in this case, a silent chain wheel may be interposed between the flywheel and the frame of the press, the power being applied through the medium of a chain belt. While the press may be inclined, in ordinary cases the upright position is preferable. This way of attaching a motor, economizes space and obviates



Ferracute Press designed for Motor Drive

possible injury to the motor or operator, thereby giving it a distinct advantage over the usual method of placing the motor on a projecting shelf or on the floor.

The press shown has a stroke of 8 inches with 3 inches adjustment; a 35-inch flywheel with a 6-inch face, weighing 750 pounds; a total height of 91 inches, and a total weight of about 5100 pounds. The pressure exerted by the ram is about 50 tons.

WESTINGHOUSE ALTERNATING-CURRENT MOTOR

The alternating-current slip-ring induction motor is especially adapted to severe, varying speed, reversing service, because of its simplicity of structure and the absence of complicated parts. The Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has recently placed on the market a new induction motor (known as the MW type) that is built especially for operating cranes, elevators, hoists, turntables, etc. This motor is illustrated in Fig. 1, and Fig. 2 shows the design of rotor.

The construction is exceptionally strong in order to withstand the heavy stresses of the service referred to; the starting torque and overload capacity are high; and the motor is capable of developing a maximum power for given dimensions. In operation it is practically noiseless, which is essential for elevator service. The construction of the frame, brackets, bearings, and shaft is the same as that of the Westinghouse type MS motor, which has been used successfully in heavy

steel mill duty. The frame is a cylindrical casting with large supporting feet and numerous openings for ventilation. The stator coils are heavily insulated, form wound, and are laid in open slots. The brackets are so designed that they give rigid support to the bearings, and they are machine split in all except the three smallest sizes.

The rotor is of comparatively small diameter so that it has a low flywheel effect and is easy to brake. It is perfectly balanced, and the windings are securely fastened in place.

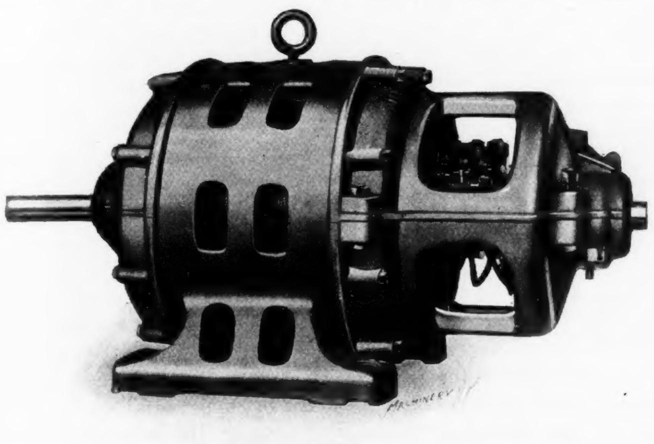


Fig. 1. Westinghouse Induction Motor for Elevator, Crane and Similar Service

These features make the rotor especially adapted for frequent starting, stopping, and reversing. The collector rings are inside the front bearing housing. The shaft is made of axle steel and is very heavy. The bearings are large babbitt-lined iron shells.

Convenience of repair has been an important consideration in the design of these motors. Removal of the upper half of either bracket gives access to the bearings and the interior of the motor without disturbing brushes or connections. The shaft can be removed and replaced without disturbing the

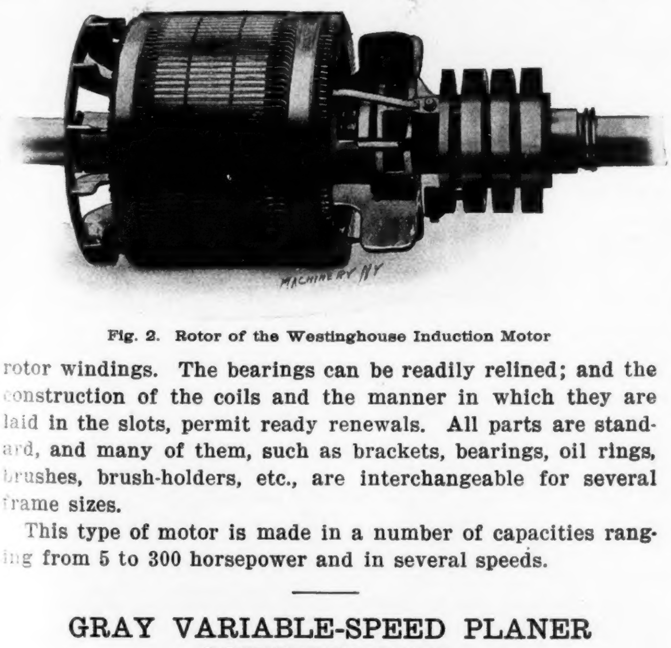


Fig. 2. Rotor of the Westinghouse Induction Motor

rotor windings. The bearings can be readily relined; and the construction of the coils and the manner in which they are laid in the slots, permit ready renewals. All parts are standard, and many of them, such as brackets, bearings, oil rings, brushes, brush-holders, etc., are interchangeable for several frame sizes.

This type of motor is made in a number of capacities ranging from 5 to 300 horsepower and in several speeds.

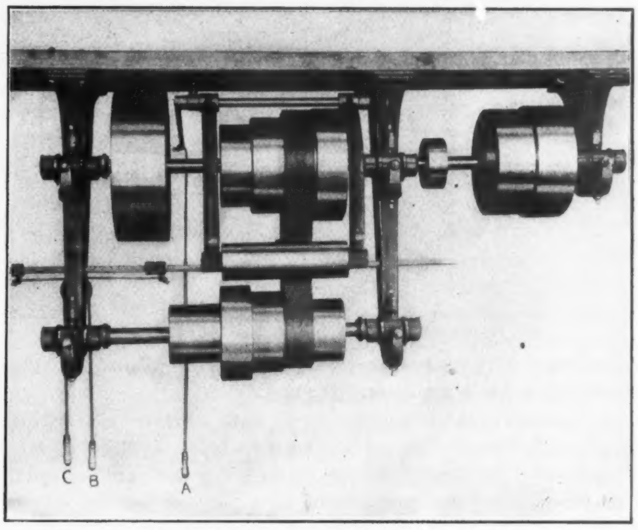
GRAY VARIABLE-SPEED PLANER COUNTERSHAFT

A simple design of variable-speed, ceiling countershaft for application to planer drives, has been brought out by the G. A. Gray Co., Cincinnati, Ohio. This countershaft gives four different cutting speeds with a constant high return speed, and the speed changes are easily made.

The drive consists primarily of two inversely-placed cones (see accompanying engraving), one of which is mounted on a constant-speed shaft which also carries the return pulley, and the other on the variable-speed shaft which carries the pulley for the cutting stroke. The constant-speed shaft, which is the upper one in the illustration, is driven from the lineshaft through a pair of tight-and-loose pulleys, and the variable-speed shaft is driven from the constant-speed shaft by an endless belt, as shown.

The speed changes are made by pulling cord *A* which raises a swinging idler and slackens the belt; the latter is then shifted by pulling either cord *B* or *C*, depending on whether the speed is to be increased or diminished. The swinging idler, by its own weight, keeps the endless belt under the required driving tension and also increases the arc of contact between the belt and cone pulleys. This belt has sufficient width to easily transmit the full power required by the planer. The momentum of the two cones supplements that of the heavy flywheel pulley, and reduces the strain on the lineshaft at the moment of reversal.

The tight-and-loose pulleys are of different diameters so that there is practically no strain on the lineshaft belt when it is running on the small or loose pulley. The pulley shafts run in large ring-oiling, universally-adjustable bearings. The small pulley located to the right of the upper cone (on the constant-speed shaft), drives the power elevating mechanism. The idler for keeping the belt under sufficient tension is keyed



Planer Countershaft giving Four Cutting Speeds and a Constant High Return Speed

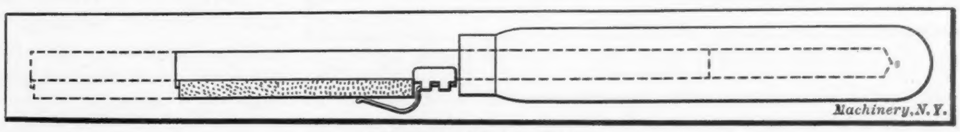
to its shaft which runs in babbitted bearings, lubricated by sight-feed oilers.

From the foregoing it will be seen that there is only one belt leading from the lineshaft to the countershaft, and no complication of shifting levers to puzzle the operator and get in his way. There are no sleeves, gears, frictions or long-hubbed pulleys running loose on their shafts and likely to stick and cut; no positive clutches or sliding gears to be bruised or broken, and no pulling of belts by hand in order to get jaw clutches or sliding gears in the correct relative position for shifting.

This countershaft is simple in construction, noiseless in operation, and speeds can be changed quickly without shutting off the power or even stopping the planer.

BADGE TELESCOPIC OILSTONE HOLDER

An oilstone holder is shown in the accompanying line engraving which is particularly adapted for the use of toolmakers and diemakers for stoning fine tools, punches, dies, etc. This holder, which is manufactured by F. J. Badge, 286 Taaffe Place, Brooklyn, N. Y., is an improved form having



Telescopic Oilstone Holder

a bar or stone-holder which telescopes into the handle. This bar can be extended, as indicated by the dotted lines, far enough to hold an oilstone 4½ inches long, or it can be pressed into the handle until only sufficient length is exposed to hold

a 2-inch stone. This adjustment enables stones of various lengths to be held close to the handle where they may be used more effectively. The bar is of V-section, and round, triangular, square, or rectangular stones can be held. An abutment on the end of the bar prevents the stone from moving endwise, and it is held by a clip or spring.

FEEDING MECHANISM FOR ROCKFORD SHAPERS

The shapers built by the Rockford Machine Tool Co., Rockford, Ill., have been equipped with a new power feeding mechanism for the head. This mechanism is free from complication and is, therefore, serviceable and not liable to get

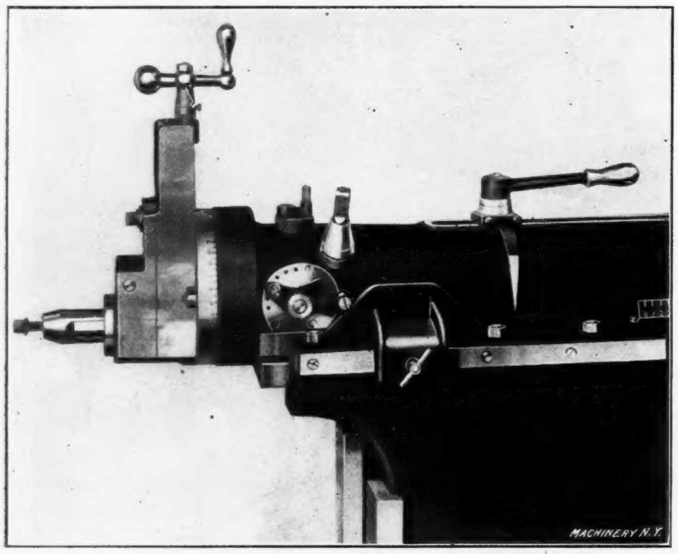


Fig. 1. Rockford Shaper with Power Vertical Feed

out of order. It feeds the tool either up or down and operates with the head set at any angle.

Fig. 1 shows the application of this feed to a Rockford shaper, and Fig. 2 illustrates its operation. A block *B*, having angular ends, is clamped to the column and can be readily adjusted to suit the position of the ram, or moved out of the way when not in use. This block is so located that the

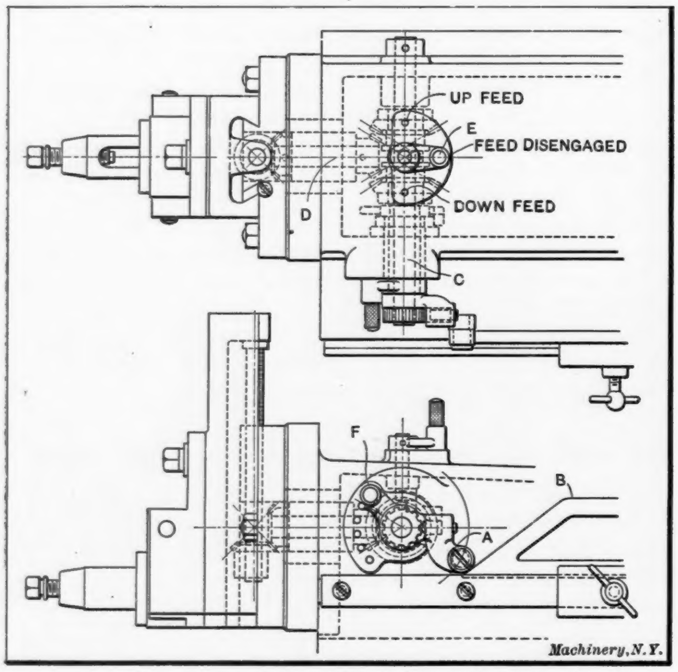


Fig. 2. Elevation and Plan of Vertical Feed Mechanism for Rockford Shaper

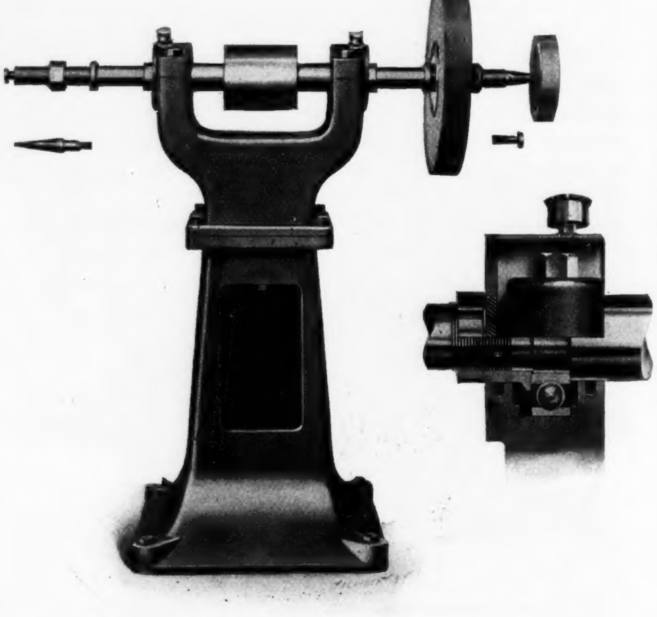
pawl-arm *A* carrying a roller, is lifted by the angular end of block *B* during the latter part of the ram's return stroke. This movement of the pawl-arm is transmitted to cross-shaft *C* which connects with the vertical feed shaft through bevel gears and an intermediate shaft *D*.

The direction of the feed is reversed by means of lever *E* which controls the position of the sliding bevel gears shown in the plan view. This lever also has a neutral position for disengaging the feed. The lever *F* on the side of the ram is for regulating the amount of feed. The position of this lever is changed by engaging a spring-pin in its end with the holes shown, and, as it is shifted downward, there is a corresponding change in the position of pawl-arm *A* in a reverse direction, which results in diminishing its rotary movement and consequently the feed. This simple arrangement gives six changes of feed varying from 0.008 to 0.048 inch.

Ordinarily the sliding block *B* should be located far enough back to prevent the pawl roller from passing beyond it at the end of the stroke. If necessary, however, the feeds can be doubled by using both ends of the block for feeding, the block being placed far enough forward to bring both ends into engagement with the pawl.

POLISHING MACHINE

The polishing machine illustrated herewith is manufactured by the Central Autogenous Welding Co., 73 Union St., Worcester, Mass. The spindle of this machine is mounted in annular ball bearings of the radial type, that have ample space for lubrication and a design of housing that prevents entrance of any abrasive from the wheels. The capacity of tnese bearings for taking thrust is 25 per cent of their radial load capacity, so that whether the edge or side of the wheel is being used, it always runs true and in the same plane.



Polishing Machine built by the Central Autogenous Welding Co.

The bearings are packed with grease to protect them, and compression grease cups are provided to keep them full constantly. A slight over-flow of this grease out of the housing, effectively prevents any abrasive from getting into the bearing, as it is carried away by the grease. The construction of one of these spindle bearings is shown by the detailed view to the right.

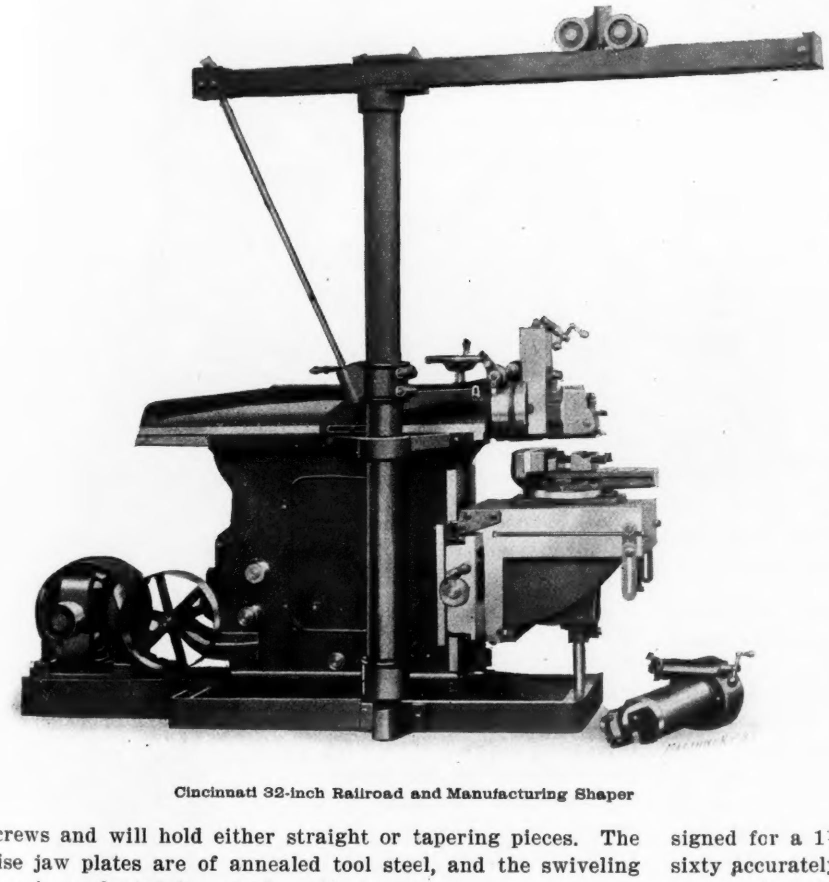
This machine can be driven either from an overhead countershaft or from one located below the floor, there being an opening for passing the belt down through the pedestal. The design illustrated is known as the No. 4 "heavy duty" polisher, and some of the principal dimensions are as follows: Length of spindle, 39¼ inches; diameter of spindle in bearings, 1¾ inch; diameter between the flanges, 1½ inch; size of spindle pulley, 5½ inches wide by 5 inches in diameter; height from floor to center of spindle, 37 inches; and complete weight, about 550 pounds.

CINCINNATI 32-INCH BACK-GEARED CRANK SHAPER

The heavy-duty back-geared crank shaper shown in the accompanying view, is a machine especially fitted for railroad

work. As much of the shaper work in a locomotive repair shop is heavy, a revolving jib crane, having a capacity of 1500 pounds, has been attached to the machine as shown. On account of the height of this crane (9 feet) the illustration does not give a correct impression as to the size of the shaper, which weighs 9370 pounds.

The head of this shaper is designed to operate on the pull-cut principle, and it has a concaving or circular planing attachment with a power feed. There is also an extended circular feeding head, (shown in the illustration just in front of the machine) that has both hand and power feeds. The knee is of special design having a tilting top which has a working surface of 30 by 24 inches. The vise shown has two clamping



Cincinnati 32-inch Railroad and Manufacturing Shaper

screws and will hold either straight or tapering pieces. The vise jaw plates are of annealed tool steel, and the swiveling base is graduated for angular adjustment.

An opening through the column just beneath the ram, provides room for keyseating long shafts or similar work. The ram has a long and wide bearing in the column, and the rail is deep, ribbed horizontally, and strongly gibbed to the column. The length of the stroke is adjusted from the working side of the machine, and its position is changed by means of a handwheel seen just back of the ram. These changes can be made while the machine is in motion or at rest. The cross traverse screw has a graduated collar reading to 0.001 of an inch, and a variable automatic feed which may be adjusted from nothing to the full feed while the machine is running.

The shafts used in this shaper are of high-carbon steel and all are accurately ground. All gears and T-slots are cut from the solid; and all flat sliding surfaces, as well as the surfaces between the apron and table, are hand scraped to surface plates. The pinions used are of cast steel and the miter gears are cut from the solid stock. This machine is the product of the Cincinnati Shaper Co., Elam St., and Garrard Ave., Cincinnati, Ohio.

REMINGTON BENCH LATHE AND ATTACHMENTS

The precision bench lathe and attachments shown in Figs. 1 to 3, are the product of the Remington Tool & Machine Co., Boston, Mass. The improvements in the lathe and its equipment include a combination screw-feed and lever-feed tailstock; a belt tension device; independent stops on the turret slide; a graduated swiveling toolpost on the forming slide; and a lever- and screw-feed for the milling attachment.

The combination tailstock is shown applied to the lathe in Fig. 1. The horizontal movement of the tailstock spindle is 3 inches, and the eccentric end of the binding bolt is adjustable for wear. Fig. 1 also illustrates the means for varying the belt tension. The legs of the bed rest on shoes, which are provided with adjusting screws, so that a lateral movement of 2 inches is obtained. With this adjustment, a continuous lapped-joint belt may be used, as the tension between the countershaft and machine can be varied as required. The stretching of new belts often results in wasting considerable time, which can be eliminated by having a convenient means of adjustment. The turret attachment, which is shown in Fig. 2, has six holes and there is an independent stop for each of the six tools. The forming slide has a swiveling toolpost graduated in degrees, so that straight forming cutters may be used for turning to any angle. The milling attachment shown in Fig. 3, has a lever for hand milling operations and a ball crank handle for screw feed.

The headstock has a three-step cone designed for a 1¼-inch driving belt. The large end flange has sixty accurately-spaced holes which are engaged by a tension-pin for indexing. The spindle is of the two-angle type. It takes ⅝-inch stock through the self-centering spring collet chucks, and ¾-inch material when a universal chuck is used. The end adjustment of the spindle is made by advancing a fiber collar that comes in contact with a shoulder on the front of the spindle. This feature enables holes ½ inch in diameter to be drilled continuously, without any sticking or hugging of the spindle in the bearings. The bearings are made of tool steel and are hardened, ground and lapped.

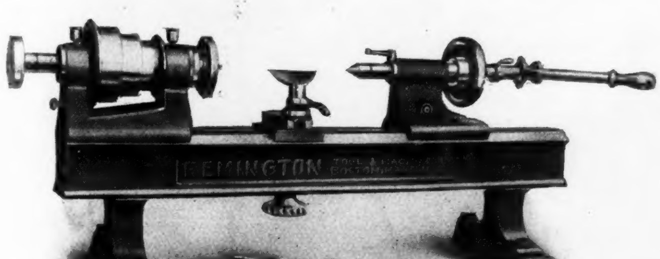


Fig. 1. Remington Precision Bench Lathe, with Lever- and Screw-feed Tailstock

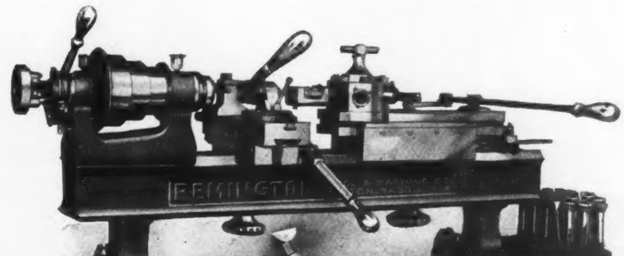


Fig. 2. Bench Lathe arranged with Turret and Forming and Cutting-off Slide

The tip-over T- or hand-rest is so arranged that the upright portion can be temporarily removed for gaining easier access to the work, without losing the original setting of the rest. The sleeve of this rest is reversed, thus bringing the binder handle at the base where it does not interfere with the

tools or hand. The eccentric locking ring used for holding the T-rest in position, does not interfere with the working tools.

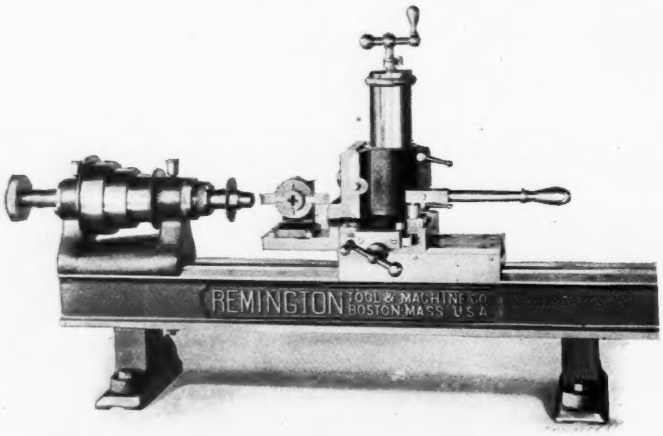


Fig. 3. The Lever- and Screw-feed Milling Attachment

This lathe has a swing of 8⅜ inches over the ways, and a 36-inch bed, giving a maximum distance between the centers of 18 inches.

NEWTON COLD-SAW CUTTING-OFF MACHINE

A 32-inch cold saw cutting-off machine that is a modification of the standard design built by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., is shown in Figs. 1 and 2. This machine is designed for sawing the webs of crankshafts, and it embodies a number of features that have been incorporated to increase production partly by reducing the idle time of the machine.

The saw blades are extra heavy and the drive sufficiently powerful to operate two saws simultaneously to their maximum efficiency. The machine is fitted with a geared feed-box giving nine changes with nine gears, and a power quick return. There is also provided a positive safety and adjustable automatic release for the fast traverse and feeds. The gear box is one of the company's standard designs, and the different combinations of gearing are brought into mesh by three sleeves, one of which is stationary, while the two outer ones slide on their shafts. The feed-screw has a bearing at

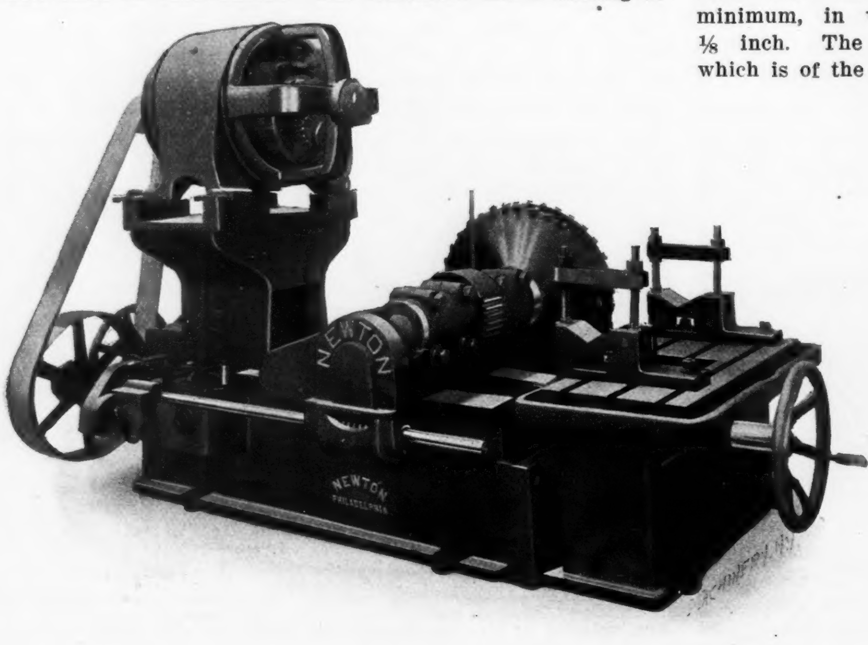


Fig. 1. Newton 32-inch Crankshaft Cold Saw Cutting-off Machine

both ends so that it is always maintained in tension, and it may be operated by handwheels located at both the front and rear of the machine for this purpose. The lever for engaging the fast traverse is operated from the front.

The machine is driven by a twenty-horsepower General Electric, 220-volt motor, having a speed range of from 500 to 1500 revolutions per minute. The drive is through a double 6-inch belt, and the motor is elevated, as shown, in order to give a greater bearing of the belt on the pulleys.

The spindle of the machine revolves in bronze-bushed, capped bearings and it is supported at each end. The spindle and the driving spur gear mounted on it (between the two bearings) are both of nickel steel. The teeth of the pinion that engages with the spindle gear, are cut from the solid shaft on which the solid bronze worm-wheel is fitted. This

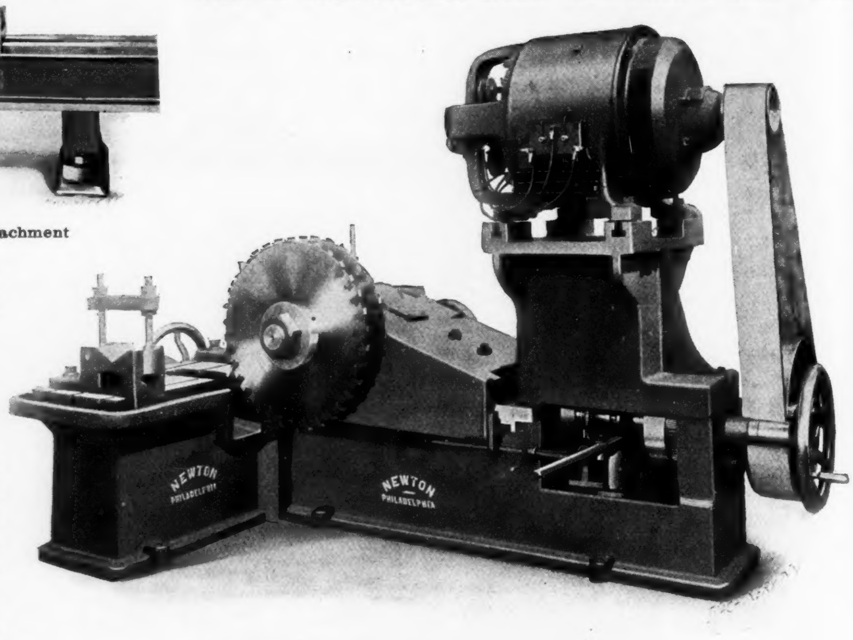
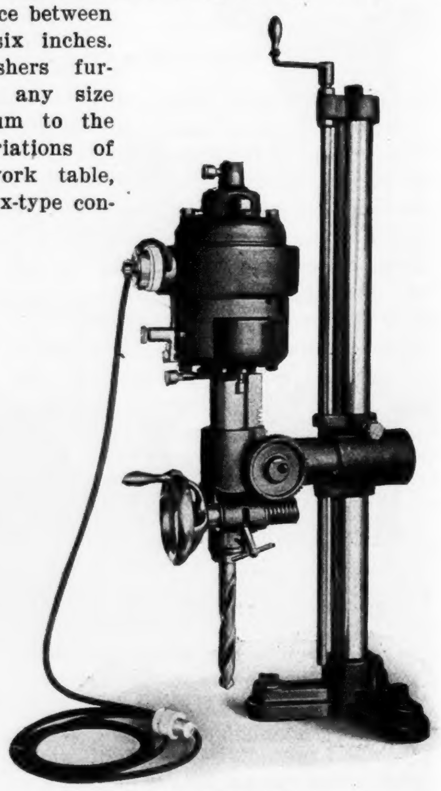


Fig. 2. Another View of the Newton Cutting-off Machine

worm-wheel has proportionately large bearings on the shaft, and teeth of steep lead. The driving worm is of hardened steel and has roller thrust-bearings. The worm gearing is encased to give continuous lubrication.

The spindle is extended to permit operating the blades at a maximum distance between their centers of six inches. The spacing washers furnished will give any size from the maximum to the minimum, in variations of ⅛ inch. The work table, which is of the box-type con-



Electrically-driven Radial Drill, manufactured by the Lamb Electric Co.

struction, has an oil pan cast integral with it for carrying off the lubricant. The work is held in V-blocks which are shown mounted on the table in Fig. 1, and are included in the equipment.

LAMB PORTABLE ELECTRICALLY-DRIVEN RADIAL DRILL

The portable electrically-driven radial drilling machine illustrated herewith has a maximum capacity for holes up to 1 inch in diameter and the drill spindle can be adjusted to any position. The current for the motor may be obtained from a lamp socket, if a power circuit is not available, and the motors are wound for either direct or alternating currents. The machine can be arranged for either a single speed of 135 revolutions per minute, or for two speeds of 135 and 230 revolutions per minute, respectively. The speed changes may be quickly obtained by simply shifting a knob. The spindle is fitted with a No. 3 Morse taper and it has a movement of 5 inches. The arm holding the spindle can be adjusted to any angle, as the motor is integral with the spindle sleeve. The column is made of steel tubing and the standard length is 3 feet; it can, however, be made longer at a slight additional cost if desired. This drill weighs 130 pounds and it is strongly constructed. The Lamb Electric Co., 20 Huron St., Grand Rapids, Mich., is the manufacturer.

ROCKFORD 14-INCH SENSITIVE DRILL

The Rockford Drilling Machine Co., Rockford, Ill., is now manufacturing the design of upright drilling machine shown in the engraving. The feeding mechanism of this drill is so arranged that it can be handled conveniently and quickly, which is a particularly desirable feature on a machine of the sensitive type.

Fourteen-inch Drill built by Rockford Drilling Machine Co.

The feed is driven by a belt operating on the cone pulleys shown. These cones give three feed changes, and the lower one is placed as low as possible to give a long feed belt, thereby increasing the frictional pull. The feeding movement is transmitted from the lower cone to the worm gearing through a steel pinion and gear, which are covered by suitable guards as shown. The feed frame is in one piece and swings on a long hinge pin which is held by a lug cast solid with the main frame of the machine. The same lever is used for starting and stopping the feed, which is controlled by pressing the lever in an upward or downward direction.

The machine has an automatic stop which is located on the opposite side and, therefore, does not show in the illustration. This stop is so arranged that the full travel of the spindle sleeve is available. A lever on the right-hand side of the machine, that is held by a suitable spring, is used in place of the former hand lever feed. This lever is adjustable as to length and can, therefore, be placed in the most advantageous position for feeding.

The small handwheel shown at the end of the shaft carrying the worm, is very convenient for facing operations. This wheel is attached to the worm shaft, and when used for feeding, the spur pinion for operating the feed is disengaged by a push lever located just above the worm shaft.

UNIVERSAL CHIP GUARD

Every machinist who has had experience on machine work realizes the need of protection for the eyes against the hot chips which fly with considerable force from the cutting point of the tool and are a source of constant danger. The Universal Stamping Co., 47 Poultney St., Buffalo, N. Y., has placed

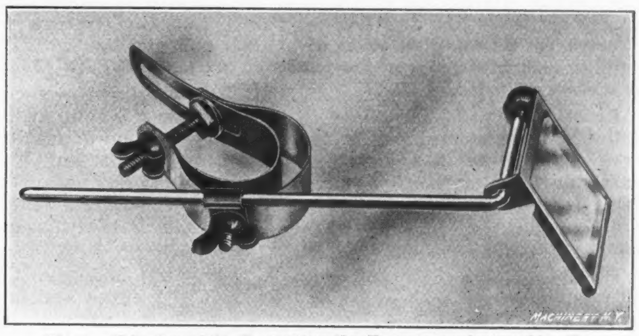


Fig. 1. Chip Guard for Protecting the Eyes, manufactured by the Universal Stamping Co.

on the market a chip guard that is designed to afford this protection without interfering with the operation of the machine. A view of this guard is shown in Fig. 1, and Fig. 2 illustrates the method of applying it to a lathe. The guard proper is made of glass, so that the tool point and work are always visible. This glass is mounted in a steel frame that is attached to a rod held by a clamp on the toolpost. The guard can be set at any angle and the rod may also be moved in any direction, thus giving a universal adjustment. As the rod is

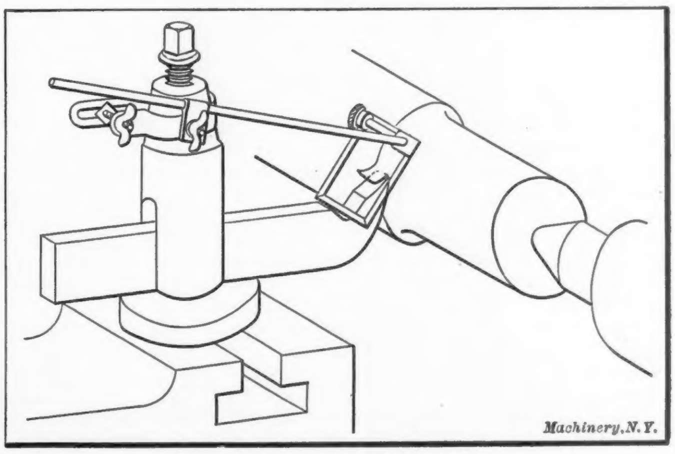


Fig. 2. Chip Guard applied to a Lathe

attached to the toolpost clamp by a swiveling connection, the guard can be quickly moved out of the way, when necessary, by swinging it upward or sideways. The clamp is so made that it can be adjusted for toolposts of different diameters. This guard is not intended for machines taking long and heavy cuts, but for that class of work which requires frequent calipering and constant attention. It is manufactured in two different sizes, known as Nos. 1 and 2. The smaller size is for toolposts up to 1¾ inch in diameter, and the larger for toolposts up to 2¼ inches in diameter. The price of this guard postpaid is 75 cents.

NEW MACHINERY AND TOOLS NOTES

Toolpost: O. K. Tool-Holder Co., Shelton, Conn. Toolpost adapted for heavy work and constructed so that the tool can be adjusted to any desired height. The construction is very compact and the parts are made of packhardened forged steel.

Lubricators: J. L. Osgood Lubricator Co., Buffalo, N. Y. Forced-feed valveless lubricators, especially adapted to machine tools, gasoline or steam engines, etc. The oil tank has two compartments, one for lubricating and the other for cutting oil, in the case of a machine tool. It contains the circulating pump which is driven by a chain belt.

Keyseater: Lapointe Machine Tool Co., Hudson, Mass. Motor-driven vertical keyseater having a two horsepower motor, and provision for automatically clearing the cutter on the return stroke, thus avoiding any drag on the work. The keyway depth is regulated by an index plate and locked finger which is positive in its action, and the feed is automatic.

Pipe Cutting Tool: Taylor-Wilson Mfg. Co., McKees Rocks, Pa. Tool for cutting pipe in the lathe, having a cutting blade and a steel disk located above it which nicks the pipe and also prevents the tool from entering too rapidly. The disk is adjustable for different diameters. This tool is designed to cut pipe or tubing ranging from 3/8 to 12 inches in diameter.

Fifteen-inch Lathe: Carroll-Jamieson Machine Tool Co., Batavia, Ohio. Double back-geared lathe with quick-change mechanism giving thirty changes for turning or screw cutting. All feeds are friction controlled, and the changes are effected by the manipulation of a knob and one handle. The double back-gears are in the ratio of 8 to 1 and 3 to 1. All gears are guarded.

Erecting Stand: Standard Motor Car Co., Scranton, Pa. Adjustable stand designed to facilitate the erection of machinery. This stand is adjustable for varying widths, and it is particularly adapted for work on automobile engines. The table for holding the part being erected, is tilting and reversible to bring the work in the most advantageous position, and when set it may be locked.

Punching and Riveting Press: Ferracute Machine Co., Bridgeton, N. J. Line of presses for punching holes and forcing rivets. The press is controlled by a foot treadle and clutch. The stroke is ordinarily 1½ inch, but it may be shortened or increased to a maximum of 2½ inches. The smallest machine of this line weighs 2300 pounds and is capable of exerting a pressure of approximately 15 tons.

Thread Gage: Wood & Spencer Co., Cleveland, Ohio. Snap thread gage designed for the rapid and accurate inspection of automobile parts. When using the gage it is unnecessary to screw the work into it, thus eliminating wear. Two different styles of gages are made, one having an adjustable blade and the other being non-adjustable. Both types are made in various sizes ranging from ¼ inch to 12 inches.

Speed Box: American Tool Works Co., Cincinnati, Ohio. Geared speed box for application to 4-, 5-, 6- and 7-foot plain and universal triple-geared radial drills. This box is of the cone and tumbler construction and provides eight changes of speed. These changes may be effected without shock, as the gears are kept rotating while changes are being made, by an auxiliary drive which is automatically engaged and disengaged by the movement of the tumbler lever.

Portable Grinder: Safety Emery Wheel Co., Springfield, Ohio. Electrically-driven portable swinging-frame grinder for grinding the fins from castings and doing similar work. The frame containing the motor and abrasive wheel is mounted on a pair of 42-inch steel wheels, and it is well balanced so that the grinder can easily be operated by one man. The grinding wheel is 24 inches in diameter and 2 inches thick; by omitting the safety collars the thickness may be increased to 3 inches.

Twenty-Four Inch Planer: Putnam Machine Co., Fitchburg, Mass. Motor-driven 24- by 24-inch planer built in various lengths to plane work ranging from 5 to 10 feet in length. The motor is mounted above the housings and is rigidly supported. All the bearing surfaces of the planer are scraped, and all shafts, etc., used in the construction are of steel. The head has a traverse of 10 inches, and its feed-screw is provided with a micrometer dial. This machine is also equipped for belt drive when desired.

Heavy Press: Ferracute Machine Co., Bridgeton, N. J. Large press designed to give a pressure of 200 tons. The height from the bed to the ram at the top of the stroke and adjustment, is 22½ inches. The ram has a stroke of 8 inches and a downward adjustment of 6 inches made by a ratchet that imparts a simultaneous movement to the two pitman screws. A side punch having a stroke of 2 inches enables punching and shearing operations to be performed while the main press is in use. The total weight of this press is about 40,000 pounds.

Upright Drilling Machine: Superior Machine Tool Co., Kokomo, Ind. In the department of New Machinery and Tools for November, 1910, we illustrated a Superior upright drilling machine equipped with a compound table, having both cross and longitudinal feeds. This machine is now being built with a positive geared feed, similar in construction to that illustrated in the February, 1911, number. The feed box is mounted on the head and the feed changes are made by conveniently-located handles. This machine can be used for either drilling or milling operations, and it is capable of handling a wide range of work.

Die-stock: The Hart Manufacturing Co., 10 Wood St., Cleveland, Ohio. Pipe threading die-stock fitted with adjustable dies and guides or centering jaws which are adjusted simultaneously to all sizes of pipe. The dies are of the chaser form which is easily sharpened, and one set of the double-ended style is used for diameters varying from ¼ to ¾ inch. The method of setting the dies to size enables them to be located with accuracy, and they are positively locked in position. They may be quickly released, which avoids turning them back over the threads. A device for cutting off pipe will be included in the equipment, if desired.

Power Hacksaw: North Wales Machine Co., Inc., North Wales, Pa. Power hacksaw equipped with tight and loose pulleys and a direct-geared drive, the gears being machine cut and guarded. The work-holding vise may be swiveled, so that stock as large as 3¾ inches in diameter may be cut at any angle not exceeding 45 degrees. The maximum capacity for straight cuts is 5½ inches. A 10-inch blade is ordinarily used, but the telescopic connecting-rod enables the use of a 12-inch blade when cutting bevels. The machine has a gravity feed, and an automatic stop which shuts off the power when a cut is completed.

Riveting Machine: F. B. Shuster Co., New Haven, Conn. Special riveter for riveting wire or round rod spokes to the rims of wheels, such as are used for agricultural machinery, etc. The wheel to be riveted is mounted on a mandrel which is adjustable on the column of the machine, for different diameters, and the spoke and wheel rim is supported by an anvil having jaws which fit and grip the spoke. As the distance between the anvil and hub mandrel remains constant for a wheel of given size, the radius of the wheel as it is turned from one spoke to another is kept practically the same. This machine will rivet spokes ranging in size from 3/16 to ½ inch.

Double-Spindle Boring Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Double-spindle machine designed for plain boring operations requiring a simple but rigid tool. The spindles are driven by a three-step cone-pulley having a pinion meshing with a large driving gear, on the hub of which is mounted a pinion that engages gears on the spindles. There are three changes of in-and-out geared feed with an automatic release and a hand adjustment. The working surface of the table is 18 by 20 inches, and cylinders having a bore 14 inches deep can be machined. Additional spindle heads can be placed on the machine for different center distances when required.

Rotary Planer: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Rotary planing machines specially adapted for finishing the ends of cast-iron and structural steel columns. The machine has two heads, each of which is driven by a 7½-horsepower motor, the power being transmitted through spiral gears to a driving worm-wheel. One of the heads is stationary on the bed, and the other can be adjusted to distances varying from 6 feet 3¼ inches, to 30 feet. This adjustment is by power, a 5-horsepower motor being used for the purpose. The cutter heads of this machine measure 26 inches over the tools, and the maximum distance between their cutting faces is 30 feet.

Hydraulic Pneumatic Pump: Nash Engineering Co., 248 Gates Ave., Brooklyn, N. Y. Hydraulic pneumatic pump adapted to exhausting or compressing air. The construction is very simple and the principle of operation ingenious. The pump consists principally of a rotor, having solid blades, which revolves within a casing of elliptical form. All the displacing and joint-forming functions are effected by water which revolves with the rotor. As this water follows the walls of the casing, it recedes and then advances toward the rotor, thus acting as a kind of water piston which does the work of compressing or exhausting air through suitable ports. The machine is both compact and durable, and the speeds are such that it may be connected directly with an electric motor.

Cylinder Grinding Machine: Brown & Sharpe Mfg. Co., Providence, R. I. Cylinder grinding machine with grinding spindle which travels in a circular path so that the work can remain stationary. This feature is particularly desirable on multiple cylinder work, or for parts which do not have the weight distributed evenly about a central axle. The work table extends beneath the spindle head and has an exceptionally long support. The drive to the spindle is by belt from a floor stand having a swinging idler which takes care of the spindle's rotary movement. This machine has a capacity for cylinders up to 7 inches in diameter and 14 inches long. The dust incident to the grinding operation, is exhausted by a fan, hose, and receiver which forms part of the equipment.

Sprue Cutter: J. C. Busch, 136 Ferry St., Milwaukee, Wis. Power-driven sprue cutter built principally for cutting gates, runners and risers on steel castings and also for trimming fins. The construction is high-grade throughout, the frame and flywheels being of cast iron, and the gears, connecting-rods, crosshead, and table of cast steel. The shafts are of forged high-carbon steel and run in bronze bushings fitted into seats bored in the castings. The gears are cut, and the knives are made of 3-inch square steel. The machine is driven by a 10-horsepower motor or its equivalent, and it has a capacity for shearing 1½-inch square stock, or a piece of equal area. This shear has successfully cut a bar measuring 1¾ inch by 3½ inches, and having a carbon content of 0.3 per cent.

Hand Punch: Whitney Metal Tool Co., 222 East State St., Rockford, Ill. Rotary hand punch which is operated by turning a spindle having a ball bearing in a bushing mounted vertically in the frame. As the ball races are in the form of a screw, the spindle has a longitudinal as well as a rotary movement, and the elimination of friction enables a maximum of pressure to be transmitted to the punch. The latter is so attached to the end of the spindle that it is prevented from rotating and simply has a vertical movement. The punch frame is pivoted and it can be inclined to various angles. This style of punch is now manufactured in three different sizes, the smallest of which will punch a 3/8-inch hole in boiler plate of the same thickness, while the largest punch has a capacity for 3/4-inch holes through 3/8-inch boiler plate. The weight of the largest size is 20 pounds.

Motor-Driven Grinder: The Springfield Mfg. Co., Bridgeport, Conn. Electrically-driven dry grinder having a motor that is entirely enclosed and a heavy base to absorb vibration as much as possible. This grinder is made in three sizes having 12 by 2 inch, 18 by 2 inch and 24 by 3 inch wheels. Wheels having wider face widths may, however, be used. The machines are made with or without safety hoods. Each grinder is equipped with large and long spindle bearings which run in self-oiled boxes. The principal dimensions of the smallest and largest sizes are, respectively, as follows: Height to center of spindle, 36 inches in each case; length of spindle bearings, 10 inches and 12 inches; diameter of spindle in bearings, 1 1/2 inch and 2 1/4 inches; distances between grinding wheels, 35 1/2 inches and 43 1/2 inches; horsepower of motors, 2 and 5; weights of machines, including hoods, wheels, and motor, 1050 and 2060 pounds.

Duplex Miller: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. No. 1 1/2 duplex milling machine designed for general work and adapted for both facing and slabbing operations. The two horizontal spindles with which the machine is equipped are mounted on each side of the platen and are adjusted vertically. These spindles are driven through worm gearing having casehardened driving worms and bronze-rimmed wheels. The spindles are threaded externally for face cutters and have internal tapers for the insertion of cutter arbors. The arbors are driven by broad-faced keys and held by retaining bolts. The minimum and maximum distances between the spindles are 3 and 28 inches, respectively. The maximum distance from the spindle center to the top of the work table is 12 inches, and the minimum distance, 1 inch. The machine has a capacity for face milling cutters up to 12 inches in diameter. The width of the work table is 15 inches, and the length, 13 feet.

Presses: Fred J. Swaine Mfg. Co., 7th & O'Fallon Sts., St. Louis, Mo. Recent improvements in inclinable open-back presses, including the use of vanadium steel in the clutch parts and shaft; lugs for tie-rods which may be easily inserted or removed; increase of die space from slide to bolster-plate, and larger beds. An additional locking point for the clutch insures the use of the press, should one of the clutch bolts or connections break or get out of order, as the defective parts can be quickly removed and the press operated with the remaining bolt. Inclining the press does not raise the front of the bed to an awkward height for the operator, as the swiveling point is near the front of the bed, thus keeping this part at practically the same height regardless of its position. All the bearings are carefully scraped, and there is an improved bearing of large size for the slide end of the pitman. When inserting dies, the crank may be turned off center without stopping the flywheel, and it is impossible for the clutch to engage. After the dies are set, the crank is turned back by hand to the starting point. These presses are made in eleven different sizes of either the geared or plain type, and have weights ranging from 350 to 9500 pounds.

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MONOPLANE CARRIES TWELVE PERSONS

Louis Breguet made a record performance March 23, at Douai, France, when he carried eleven passengers in his monoplane a distance of two miles. The flight was made at a height varying from fifty to seventy-five feet. The total weight of the twelve persons was 1315 pounds, and the combined weight of the machine and its occupants was 2602 pounds. The best previous performance of the kind was made by M. Le Martin, who on February 2 took up seven passengers on a five-minute trip.

* * *

Since the announcement of the erection of the Woolworth Building in New York was published in the December number the plan has been changed by the acquisition of the corner on Broadway, and a much larger and higher structure will be erected. The building will occupy the entire frontage on Broadway between Barclay St. and Park Place. It will be 138 feet higher than the Metropolitan tower and, of course, the highest commercial structure in the world.

LARGE BRONZE DRUM CASTING

The accompanying illustration shows an interesting and rather exceptionally large bronze drum casting. The drum is 12 feet long, 5 feet in diameter, and is used as the drying surface in a large vacuum rotary drum dryer. The drums are generally made of dense air furnace iron, but in this case, it was necessary to use a high-quality bronze drum, owing to the fact that the vegetable extract to be dried on the drum would become discolored if it came in contact with the iron.

The mold for this casting was swept up in dry sand, the core being swept up in loam. When the casting was poured, the mold was in a vertical position, thus accounting for the very clean surface free from any blow-holes. It required 16,000 pounds of metal to pour the casting, and on account

Large Bronze Drum Casting, 12 feet Long, 5 feet Diameter, Weight 16,000 Pounds

of this large quantity, it was necessary to melt the metal in a 48-inch cupola.

The practice of melting bronze in a cupola is unusual, but the Buffalo Foundry & Machine Co. of Buffalo, N. Y., who made the casting, has been very successful in following this practice where large quantities of metal are required.

* * *

The National Metal Trades Association holds its thirteenth annual convention at the Hotel Astor, April 12 and 13. "A wider scope—multiplied influence—a progressive and constructive policy, supported by a responsive membership, all have assisted in coping with the many cooperative problems which will be dealt with at this convention." An important feature of the program will be welfare work, including sanitation, safety devices, first aid to the injured, employes' clubs and employes' dining-rooms. The program will include papers on other topics of interest to the members. Robert Wuest, commissioner, New England Bldg., Cleveland, Ohio.

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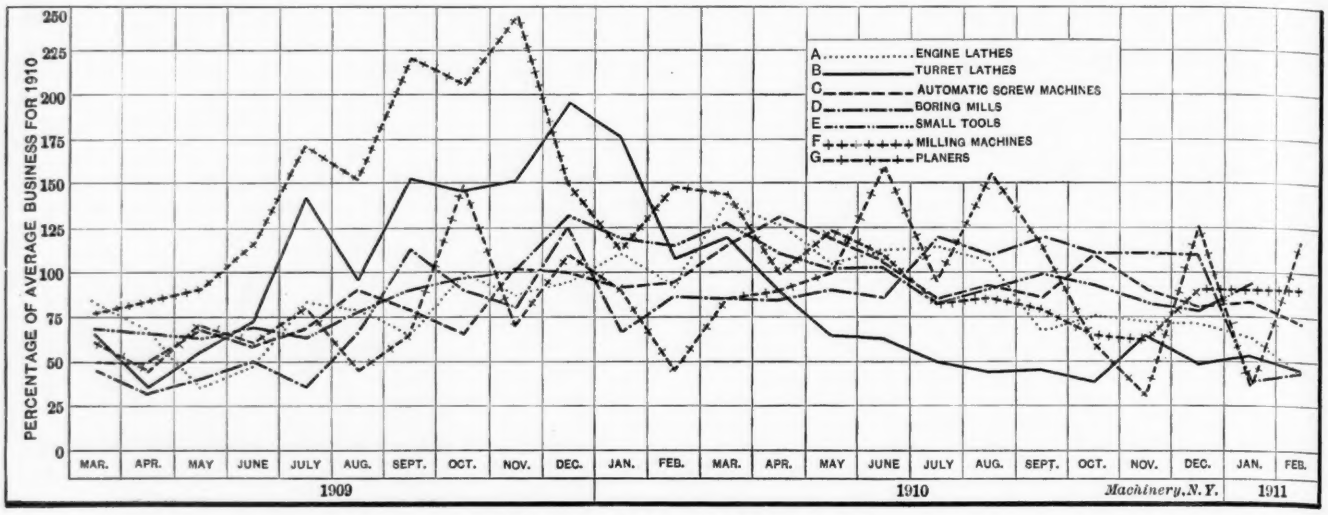
The assembling of a $1250 automobile built in one well-known Western factory costs $16.50.

MACHINERY'S CHART OF TRADE FLUCTUATIONS

Showing the variations of business in the Machine Tool industry for twenty-four months, based on information furnished by seven large manufacturers. This list will be extended to cover other lines. The curves are plotted in percentages, taking the average monthly sales of 1910 as the base.



PERSONALS

James R. Mansfield, superintendent of the Bay State Brass Co.'s foundry, Haydenville, Mass., has resigned.

Irving S. DeRochement of New Haven, Conn., has taken the position of superintendent of the Bay State Brass Co.'s foundry, Haydenville, Mass.

J. A. B. Patterson, secretary of the Standard Gauge Steel Co., Beaver Falls, Pa., returned about the middle of March from a month's sojourn in Florida.

George W. Armstrong has been made superintendent of the newly-organized Lester & Wasley Co., Inc., Norwich, Conn., manufacturers of "Leader" envelope machines.

Charles Napier, of the Quality Saw & Tool Works, Springfield, Mass., sailed in March for a four weeks' business trip to England and Scotland in the interests of the company.

Carl Falk, late sales manager for the Herman Pneumatic Machine Co., has become the Buffalo representative of the Mumford Molding Machine Co., 30 Church St., New York.

L. F. Hussey has resigned the position of advertising manager for the Wells Brothers Co., Greenfield, Mass., to fill the position of advertising manager for the Standard Tool Co., Cleveland, Ohio.

J. W. Bourn, who for several years was foreman, and later instructor of apprentices, for the Geo. V. Cresson Co., Philadelphia, Pa., has resigned and taken a position with the Curtis Publishing Co., Philadelphia, Pa.

A. Pawling, president of the Pawling & Harnischfeger Co., crane builders, Milwaukee, Wis., has gone with his family on an extended automobile trip through the Southern and Pacific Coast states. They will return to Milwaukee next June.

Prof. W. F. Schaphorst of the mechanical engineering department of the New Mexico College of Mechanic Arts, has resigned his position there to become a technical writer on the staff of A. Eugene Michel, advertising engineer, New York.

A. E. Martin has resigned the position of assistant superintendent with the Quincy, Manchester, Sargent Co. of New York and Chicago, after eight years of service, to take the position of general superintendent of the John H. McGowan Co., Cincinnati, Ohio.

L. W. Orr, formerly of Mercer, Pa., has purchased an interest in the Modern Tool Co. of Erie, Pa., and has been made general manager of the company. Mr. Orr has had a large business experience and expects to greatly enlarge and develop the activities of the company.

Carl J. Rolander, who for twenty-four years has been in the employ of the Prentice Bros. Co., as a foreman, recently resigned to enter business for himself. He has seen the Prentice Bros. shop grow from small beginnings to its present state, as one of the largest firms of its kind in Worcester.

W. R. Hulbert, manager of sales, Goldschmidt Thermit Co., addressed the Cleveland branch of the American Chemical Society at its March meeting on the subject of the thermit welding process. Mr. Hulbert gave an actual demonstration of the process by making a number of welds on wrought iron and steel sections and pipe.

G. Hüttner, partner of M. Koyemann, Düsseldorf, Germany, importer of machine tools, sailed for home March 16 after spending four weeks in America in the interests of his firm. Mr. Hüttner found conditions in our machine tool trade better than in Germany, and sees unlimited possibilities here for manufacturing growth.

Robert L. Windholz, who for several years was vice-president of the Vandyck Churchill Co., has resigned his position and will soon open an office in New York. Mr. Windholz will act as special Eastern representative for several prominent machine tool builders. His temporary address is Room 1558, 50 Church St., New York.

John O. Simpson assumed the duties of equipment engineer of the Remington Arms Co., Ilion, N. Y., March 1. He will have charge of the engineering and drafting departments and toolroom, machine shop and blacksmith shop. Mr. Simpson comes from Waterbury, Conn., where he was connected for several years with the New England Watch Co. Prior to that connection, he was with the Pratt & Whitney Co., Hartford, Conn.

George H. Adair, who has been manager of the Seattle branch of Fairbanks-Morse & Co. for the past five years, has resigned from that company, and, in connection with his father, George B. Adair, and others, has purchased the business of the Kilbourne & Clarke Co. The new concern will be known as the George B. Adair & Son Co. One of the first lines to be handled will be the products of the Foos Gas Engine Co. of Springfield, Ohio.

F. Mandon, general manager of Fenwick Frères & Co., Paris, France, arrived here on March 11, for a stay of six or seven weeks. Mr. Mandon, who is well known here, and has many friends in the trade, says that his company has recently increased its capital stock and enlarged and strengthened its selling organization, which covers France, Belgium, Spain and Portugal, Switzerland and Italy, working each territory from its own headquarters with its separate trained staff. Fenwick Frères & Co. handle American machine tools exclusively, and have the utmost faith in the ability of American tools to hold the foreign market against imitations, if American manufacturers generally will cooperate effectively with their foreign representatives, as some of them are now doing. One of the chief objects of Mr. Mandon's visit is to arouse American machine tool builders to the necessity for making energetic efforts, intelligently and systematically, to hold and increase their foreign trade, by demonstrating the higher efficiency of American tools. Mail for Mr. Mandon should be sent in care of Brown & Sharpe Mfg. Co., Providence, R. I.

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OBITUARIES

Charles H. Wilson, general manager of the United Shoe Machinery Co., died at his home in West Medford, Mass., February 20, aged fifty-three years.

Leroy S. White died at his home in Waterbury, Conn., February 17, aged eighty-two years. Mr. White was the inventor and patentee of many valuable machines, processes and improvements, particularly along the lines of manufacture of silverware and brass novelty ware.

Edward J. Pennington, inventor and promoter, died at his home in Springfield, Mass., March 5, aged fifty years. Pennington was one of the early inventors of flying machine apparatus, and although he did not succeed in practical develop-

ment, his improvements of the light gas engine undoubtedly helped later inventors to solve some of the problems of aviation. In 1891 he produced a four-cylinder motor of eight horsepower, which weighed only thirty-two pounds. This motor was not a success when attached to a dirigible balloon and was applied to a bicycle, but the idea did not then meet with favor for bicycles. The engine was applied to road vehicles but, finding the conditions unfavorable in this country, he went to England, where in 1896 he gave successful exhibitions of a kerosene motor driven carriage in London.

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COMING EVENTS

April 3-5.—Triple joint convention of the Southern Supply and Machinery Dealers' Association, National Supply and Machinery Dealers' Association, and American Supply and Machinery Manufacturers' Association, at Louisville, Ky. Seelbach Hotel, headquarters. Alvin M. Smith (Smith-Courtney Co., Richmond, Va.), secretary-treasurer, S. S. & M. D. A.; Thomas A. Fernley (Philadelphia, Pa.), secretary-treasurer, N. S. & M. D. A.; F. D. Mitchell (309 Broadway, New York), secretary-treasurer, A. S. & M. M. A.

April 10-11.—Congress of Technology, Boston, Mass., celebrating the fiftieth anniversary of the granting of the charter to the Massachusetts Institute of Technology. The Congress promises to be of unusual interest not only as marking a period in the development of one of the world's great technical schools, but because it marks also the rise and high development of all that is now included under the names "engineering" and "applied science."

April 11.—Monthly meeting of the American Society of Mechanical Engineers, 29 West 39th St., New York, to discuss paper, "Economic Importance of the Farm Tractor," by L. W. Ellis. Following this paper, Dr. Charles E. Lucke will give a talk upon the mechanical equipment of farm tractors, illustrated by views taken at the Canadian Industrial Exhibition held in Winnipeg, Manitoba, last summer.

April 12-13.—Thirteenth annual convention of the National Metal Trades' Association at Hotel Astor, New York.

April 12-13.—Meeting of the National Association of Cotton Manufacturers at the Massachusetts Institute of Technology, Boston, Mass. C. J. H. Woodbury, P. O. Box 3672, Boston, Mass., Secretary.

May 18-19—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J. Marlborough-Blenheim Hotel, headquarters. Charles L. Hildreth, secretary, Worcester, Mass.

May 18-19.—Semi-annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, Youngstown Ohio. Prof. Frank E. Sanborn, Columbus, Ohio, secretary-treasurer.

May 30-June 2.—Sixty-third meeting of the American Society of Mechanical Engineers, at Pittsburg, Pa. Office of local committee, 2511 Oliver Bldg., Pittsburg, Pa.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics', and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

September 1-December 1.—Exhibition of machinery, at Bush Terminal, New York City, under the auspices of the Bureau of National Industries, 11 Broadway, New York City.

NEW BOOKS AND PAMPHLETS

Bulletin of the Massachusetts Institute of Technology, Boston, Mass., Volume 46, No. 2, for January, 1911, containing the president's report.

An Investigation of Built-Up Columns Under Load. By Arthur N. Talbot and Herbert F. Moore. 64 pages, 6 x 9 inches. 28 illustrations. Bulletin No. 44. Published by the University of Illinois, Urbana, Ill.

Statistics of Railways in the United States. Interstate Commerce Commission. 978 pages, 6 x 9 inches. Edw. A. Mosely, secretary. Prepared by the Bureau of Statistics and Accounts, Washington, D. C.

Features of Producer-Gas Power-Plant Development in Europe. By R. H. Fernald. 27 pages, 6 x 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 4.

Bulletin of the University of Missouri, School of Mines and Metallurgy, Volume 3, No. 1, for December, 1910, contains an article entitled "Some Relations Between the Composition of a Mineral and Its Physical Properties."

American Institute of Electrical Engineers, New York. Year book for 1911, containing constitution and by-laws, with general information and a list of members of the society. Ralph W. Pope, secretary, 29 W. 39th St., New York.

Proceedings of the Eighteenth Annual Convention of the International Railroad Master Blacksmiths' Association. 284 pages, 6 x 8½ inches. A. L. Woodworth, secretary, Cincinnati, Hamilton and Dayton Railroad, Lima, Ohio.

Arts-Crafts Lamps. By John D. Adams. 87 pages, 5 x 7 inches. Illustrated. Published by Popular Mechanics Co., Chicago, Ill. Price, 25 cents.

This is one of the series of hand-books on industrial subjects being published by *Popular Mechanics* and should prove useful to people who are fond of making small art pieces at home.

Current Railway Problems. By Samuel O. Dunn. 85 pages, 5 x 6½ inches, paper. Published by the *Railway Age Gazette*, New York.

At the present time when railways and their methods are constantly in the limelight of the Interstate Commerce Commission's investigations, this little pamphlet published by the *Railway Age Gazette* for free distribution, appears opportunely. The articles contained are: Valuation of Railways, with Especial Reference to the Physical Valuation of Minnesota; Shall Railway Profits be Limited? Railway Rates and Railway Efficiency; and The New Long and Short Haul Law.

Heat. By J. Gordon Ogden. 113 pages, 5 x 7 inches. Illustrated. Published by the Popular Mechanics Co., Chicago, Ill. Price, 25 cents.

This book consists of a series of articles, each complete in itself, yet all pertaining to heat and its relation to modern mechanics, written in a simple form for popular reading. It cannot in any sense be considered a treatise on the subject, the treatment being very superficial, as it must necessarily be in such a small book. However, it is admirably suited for the purposes for which it is intended, the aim being to give the layman a general knowledge of thermodynamics.

How to Read Plans. By Charles G. Peker. 104 pages, 5 x 7½ inches. 81 illustrations. Published by the Industrial Book Co., New York. Price 50 cents.

This is a simple little book on the fundamentals of reading drawings, dealing more particularly with architectural work, and therefore intended for artisans connected with the building trades. This issue is the second edition of the work, revised and enlarged. The contents are as follows: Different Kinds of Drawings; Plans, Elevations and Sections; Shade Lines; How Sections are Represented; How Different Materials are shown in Section; Dimensions; Center Line; Projection Lines; Reading Dimensions; Checking Dimensions; Scales; General Drawings; Elevations and Plans; Relation of Different Parts of a Drawing to Each Other; Views Necessary for a Working Drawing; Detail Drawings; Blueprints; Mounting Blueprints; Altering Blueprints; Coloring Blueprints; Reading a Simple Plan; Perspectives; and Conventional Methods and Devices.

Engineering Index Annual. 471 pages, 6½ by 9½ inches. Published by *The Engineering Magazine*, New York and London. Price $2.00.

This index has come to be recognized as an essential feature of every engineering library where it is desired to have much technical information readily available. It is compiled from the monthly index sheets published as a part of *The Engineering Magazine*, and also in separate pamphlet form, printed on one side for filing purposes. This annual compiles all these indexes for the year 1910, in one book, giving the title of the article, a brief statement of its contents, the approximate number of words it contains, and the name and date of the publication in which it appeared. The subjects covered include civil, electrical, mechanical, marine and naval, and railway engineering, and industrial economy, mining and metallurgy, and street and electric railways. A useful feature has been added to this volume in the form of an assembly of the significant words in the titles of the various articles, under their respective general heads and sub-groupings. This series of leading words adds materially to the usefulness of the book from the busy engineer's standpoint.

Scientific Management. By Louis D. Brandeis. 92 pages, 6½ by 9½ inches. Published by *The Engineering Magazine*, New York and London. Price $1.00.

The name of Mr. Brandeis is so well known from the publicity he obtained by the contentions he advanced that a saving of $1,000,000 a day might be effected on the American railroads by scientific management that no further introduction is necessary. This seemingly broad statement was made at the hearing given the railroads and shippers by the Interstate Commerce Commission, when the railroads early last year made an attempt to raise the freight rates. This book is part of Mr. Brandeis' brief, constituting a digest of the testimony given by Emerson, Gantt, Gilbreth, Hathaway, Dodge, Towne, Scheel, Kendall, Going, and others at this hearing, showing just what testimony was offered as to the profitable results accruing from the use of the efficiency methods that have been proved in manufacturing concerns, and it discloses the basis for the much-quoted and much-misunderstood statement regarding the possible $1,000,000 a day saving. To all interested in these new theories of scientific management and its possibilities, this book will prove both valuable and interesting.

Annual Report of the Smithsonian Institute, 1909. 751 pages, 6 by 9 inches. Illustrated. Published by the Smithsonian Institute, Washington, D. C.

This work published annually by the Smithsonian Institute, as has been the custom for years, contains in addition to the usual reports, a long series of valuable articles on the different phases of scientific development, gleaned from world-wide sources; it is cosmopolitan in its make-up, emphasizing the fact that science knows no country. Among the articles contained are the following: "The Future of Mathematics," by Henri Poincaré; "What Constitutes Superiority in an Airship," by Paul Renard; "Researches in Radiotelegraphy," by J. A. Fleming; "Recent Progress in Physics," by Sir J. J. Thomson; "Production of Low Temperatures and Refrigeration," by L. Marchis; "The Nitrogen Question from the Military Standpoint," by Chas. E. Munroe; "The Mechanism of Volcanic Action," by H. J. Johnston-Lavis; "Conservation of Natural Resources," by James Douglas; "Albert Gaudry and the Evolution of the Animal Kingdom,'" by Ph. Glangeaud; "Charles Darwin," by August Weissman; "Recent Discoveries Bearing on the Antiquity of Man in Europe," by George Grant MacCurdy; "European Population of the United States," by W. Z. Ripley; "The Republic of Panama and its People," by Eleanor Yorke Bell; "The Relation of Science to Human Life," by Adam Sedgwick.

An Investigation of Built-up Columns under Load. By Arthur N. Talbot and Herbert F. Moore. 64 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 44.

The investigation covered by this bulletin had in view the experimental determination of: (1) the way in which the compressive stresses in built-up columns vary over the cross-section of the channels or other component parts, and throughout their length; (2) something about the amount and distribution of stress in the lattice bars of columns, and also the action of similar bars under separate tests with similar conditions of fastening and eccentricity; and (3) the general relation which exists between the component parts and the column as a whole. Emphasis is placed on measuring the distribution and range of stress over the various parts of the column. The investigations include tests on a steel column built up of angles, plates, and lattice bars, all parts being light with respect to the size of the column, and four wrought iron bridge posts which had seen long service in a bridge truss, these two tests being made in a testing machine. A third test was made on three posts and a top chord in a railroad bridge under service, where actual working conditions were maintained by using a locomotive and cars as the load. Some interesting conclusions have been drawn from the experiments.

Elements of Graphic Statics. By Wm. L. Cathcart and J. Irvin Chaffee. 312 pages, 6 by 9 inches. 159 illustrations. Published by D. Van Nostrand Co., New York. Price $3.00.

This book differs from the majority of text-books on the subject, in that it is primarily written for students of mechanical and marine engineering. Most treatises, after developing the necessary underlying principles, go on to show their application to structural work, such as bridges, steel buildings, etc., where in practice they meet with their greatest application. For this last reason, the field of use among mechanical and marine engineers has been more or less neglected from the text-book standpoint. This treatise, while dealing with the customary applications to steel structures, pays particular attention to mechanisms. The chapter on the graphics of friction and the one on moment diagrams for shafting, are particularly good, all the examples being illustrated fully with line drawings. The graphical solution of frictional problems becomes very simple by a study of the book. The chapters are as follows: Graphic Arithmetic; Graphic Measurement of Areas; Forces: Concurrent, Non-Concurrent, Non-Parallel; Parallel Forces; Couples, Center of Gravity; Moments; The Fundamental Theory of Beams (two chapters); Framed Structures; Rod Trusses, Braced Cantilevers; Bridge Trusses; The Graphics of Friction; and Moment

Diagram for Shafting. In addition to the text matter, there are a considerable number of test questions by which the student may apply what has been learned.

MECHANICAL ENGINEERING. By Charles M. Sames. 220 pages, 4 x 6½ inches. Published by Charles M. Sames, Jersey City, N. J. Price, $2.00.

This hand-book is a compact and up-to-date digest of mechanical engineering science, embracing a wide range of subject matter. It is printed on rice paper, and has flexible leather covers. Weighing only 6 ounces and with a thickness of slightly over ½ inch, it may be conveniently carried in the pocket. This is the fourth edition, and is very materially revised and enlarged and contains a great deal of new matter. The book is the result of the writer's endeavor to arrange a greater part of the reference information usually required by mechanical engineers, into as small a volume as possible, and in its preparation various standard treatises have been consulted. An idea of the contents of the book may be gained when it is mentioned that there are over 900 items in the index. The general divisions of the book are as follows: Mathematics; chemical data; materials; strength of materials, structures and machine parts; energy and the transmission of power; heat and heat engines; hydraulics and hydraulic machinery; shop data and electro technics. It is probably one of the most compact hand-books on the market, containing an infinite amount of very valuable information in remarkably small space. The manner in which it is kept thoroughly up-to-date is emphasized by the fact that a small dissertation is included on aeroplane design. The very latest information on the power required by machine tools is also included. This edition is worthy of the continuance of the reception heretofore accorded it.

ENGINEERING DIRECTORY, 1911. 1379 pages, 4¾ x 6¾ inches. Published by The Crawford Publishing Co., 209-213 N. Jefferson St., Chicago, Ill. Price $5.00.

This useful engineering directory is now passing into its eighteenth year, under a new name, formerly being called the "Domestic Engineering Directory." The aim of the publishers is to put forth a book that will be a complete directory of the plumbing, heating, lighting, power plant and mill supply industries in the United States, and is intended for the daily use of the jobber, manufacturer and retailer of these goods. The contents of the book are given in the following: Directory of jobbers of plumbing and heating supplies; directory of jobbers and dealers in mill, steam, mine, railway and heating supplies, tools and machinery; directory of wholesale dealers in machinery; directory of wholesale dealers in electrical supplies; directory of electric light and power plants; directory of waterworks companies; directory of gas companies; directory of prominent architects; directory of purchasing agents of principal railroads; alphabetical list of manufacturers of plumbing, heating, lighting, power plant, mill, mine and railroad supplies, tools and machinery; classified list of products of manufacturers of plumbing, heating, lighting, power plant, mill, mine and railroad supplies, tools and machinery, giving trade names or brands by which the goods are known. The last division is necessarily the greatest, and is divided and subdivided to such an extent that very few things required by the classes to which this directory applies are omitted. In general make-up it resembles engineers' handbooks, being printed on fine paper, with red leather binding. Being only 1½ inch thick and of the previously stated superficial size, it is very convenient to handle.

THE SLIDE RULE. By Charles N. Pickworth. 118 pages, 5 x 7 inches. 34 illustrations. Published by D. Van Nostrand Co., New York. Price, $1.00.

Little need be said of the value of this practical little manual of the slide rule, for its popularity is evidenced by the fact that it is now passing into its twelfth edition. While practically the same as the last edition, it has been slightly revised, and the contents extended so as to include descriptions of several new slide rules. A section explaining the significance of various gage points and other markings on slide rules has also been added. It is a thoroughly practical book in every sense, especially from the standpoint of new uses, for it is full of practical applications of the slide rule, making it possible for anyone to become acquainted with its use by a perusal of the book. The sections are as follows: Introductory; Mathematical Principle of the Slide Rule; Notation by Powers of 10; Mechanical Principle of the Slide Rule; Primitive Slide Rule; Modern Slide Rule; Notation of the Slide Rule; Cursor or Runner; Multiplication; Division; Use of the Upper Scales for Multiplication and Division; Reciprocals; Continued Multiplication and Division; Multiplication and Division With Slide Inverted; Proportion; General Hints on the Elementary Uses of the Slide Rule; Squares and Square Roots; Cubes and Cube Roots; Powers and Roots by Logarithms; Other Methods of Obtaining Powers and Roots; Combined Operations; Hints on Evaluating Expressions; Gage Points; Examples in Technical Calculations; Trigonometrical Application; Slide Rule With Log-log Scales; Special Types of Slide Rules and Long Scale Slide Rules; Circular Calculators; Slide Rules for Special Calculations; Constructional Improvements in Slide Rules; Accuracy of Slide Rule Results; and Appendix.

MECHANICAL DRAWING FOR HIGH SCHOOLS. By Berthe E. Spink, Percy H. Sloan, Albert W. Evans, Carl Durand, and Fred W. Zimmermann. Book I, 90 pages; book II, 185 pages; 10½ by 7 inches. Illustrated. Published by Atkinson, Mentzer & Grover, Chicago, Ill. Price: part I, 65 cents; part II, 80 cents.

There are so many textbooks on mechanical drawing, that unless each new one has something decidedly distinctive, it is coming into a field already over-supplied. However, these two books on mechanical drawing actually meet a demand that has been more or less imperfectly filled by other books; this demand is for a book that will meet the requirements of secondary schools, and which will therefore require to be much less technical than that commonly used in engineering colleges. As the preface states, the authors have long felt that a printed text in the hands of the pupils is essential to the proper presentation of the subject, to the same extent that texts are necessary to the right teaching of other branches of mathematics. As previously mentioned, the books are primarily intended for use in high schools. Book I is devoted to the first three years' work, and is the result of the collaboration of the five authors. This book explains and illustrates the rudiments of drawing in a complete and simple manner, interspersing just sufficient descriptive geometry without making a puzzle-book, as many books on the latter subject prove to be for students. Book II is on advanced work for use by the fourth year high school students. Instead of being collaborated like the first book, it has been prepared in sections by the individual authors. The sections of this part are: Shadow projection and linear perspective; machine drawing; and architectural drawing. All are well treated, especially the mechanical section, where the rudiments of machine design are considered in conjunction. For books to be used in secondary schools, they appear to be well suited, and should be in demand.

APPLIED THERMODYNAMICS FOR ENGINEERS. By Wm. D. Ennis. 438 pages, 6¼ by 9½ inches. 316 illustrations. Published by D. Van Nostrand Co., New York. Price $4.50.

The very term, "thermodynamics," is looked upon by most people at all familiar with engineering, with a remarkable degree of awe, no doubt caused by the number of text-books that have been published in which the solution of problems involving the differentiation of independent variables, seems to be the predominant feature. This subject seems to have offered a remarkable field for a master of the calculus to expand upon, as there are so many correlated qualities that some wonderful mathematical treatments are possible. This, therefore, has tended towards the practical application of thermodynamics being lost sight of, and the subject becoming an Eldorado for mathematicians. Realizing the need for a book occupying a midway position between these highly mathematical text-books, and those which run too much toward empiricism, Prof. Ennis has prepared this book, and we can fully endorse it as filling the field for which it is intended. Higher mathematics are used as little as is possible, and only where the solution demands their use. In addition, the practical application of the theory is fully dealt with for numerous thermodynamic machines, such as engines of all kinds, ice machines, etc., showing the modifications that the theory must receive to be put to practical use. While Prof. Ennis is an authority on the subject, numerous treatises have been consulted in preparing this book. In addition, the standard practice of many engineering firms is represented by the numerous drawings included in the work. The chapters are as follows: The Nature and Effects of Heat; The Heat Unit, Specific Heat, First Law of Thermodynamics; Laws of Gases, Absolute Temperature, The Perfect Gas; Thermal Capacities, Specific Heats of Gases, Joule's Law; Graphical Representations, Pressure-Volume Paths of Perfect Gases; The Carnot Cycle; The Second Law of Thermodynamics; Entropy; Compressed Air; Hot-air Engines; Gas Power; Theory of Vapors; The Steam Engine; The Steam Turbine; Results of Trials of Steam Engines and Steam Turbines; The Steam Power Plant; Distillation, Fusion, Liquefaction of Gases; and Mechanical Refrigeration.

INDUSTRIAL PLANTS. By Charles Day. 294 pages, 5½ x 7½ inches. Illustrated. Published by the *Engineering Magazine*, New York. Price, $3.00.

This treatise on industrial plants and their arrangement and construction by such a prominent authority as Mr. Day should be well received, especially in this present day when competition is becoming so keen that efficient works management is an absolute necessity. This volume forms a valuable addition to any library on works management. The main purpose of the book is to prove that efficiency and economy in manufacture are of equal importance with the mere operation of the plant in which the processes of production are carried on. The factors considered by Mr. Day are the primary ones which should be considered, being the arrangement and construction of the works. They concern the organic constitution of the factory and are hence of more potential importance even than systems of management which concern functional conditions. The major portion of the book is founded upon a series of lectures delivered by the author before the Graduate School of Business Administration, Harvard University, and the engineering students at Columbia University. The chapters included are as follows: General Classification of the Work; Determination of Specific Requirements; Selection of the Site and Definition of Building and Equipment Features; Detailed Plans and Specifications; Construction Work and Installation of Equipment; Period of Occupation and Commencement of Operation; Routing, a Prime Factor in Layout; Metal-Working Plants; Machine Shops and Their Specific Requirements; Modern Industrial Plants; Value of an Engineering Organization to the Project; Compensation for Engineering and Construction Service. This book is of especial value to the metal working industry, as the last few chapters are devoted specifically to problems dealing with the laying out of such plants. The matter is treated from a practical standpoint, actual successfully operating examples of the principles laid down in this book being cited to prove the points that the author is attempting to emphasize as being essential to a proper system of works management. The book is indeed one that should find its way into all libraries of works management.

THE STEEL WORKERS. By John A. Fitch, edited by Paul N. Kellogg. 380 pages, 6 by 9 inches. Illustrated. Published by the Charities Publication Committee, New York, under the Russell Sage Foundation. Price $1.50; postage, 21 cents extra.

In this interesting book, the complete industrial conditions under which the steel operatives work are dealt with in detail. The book from every standpoint is comprehensive, and depicts vividly the body-destroying nature of the steel industry, with its insatiable desire for new and greater production records. Mr. Kellogg, the director of the Pittsburg Survey, states in his foreword: "The issues which Mr. Fitch takes up are of a sort which are not publicly discussed in the mill towns of the Pittsburg district. Old employes do not dare to petition their employers to consider them. Mr. Fitch makes articulate what the steel industry means to the men employed in it—for whom it makes up the matter of life, and who have no voice." The subject is discussed in eighteen chapters, divided into four divisions: The Men and the Tools; The Struggle for Control; The Employers in the Saddle; and The Steel Workers and Democracy. These titles practically speak for themselves; in them is told a tale of terrible truths that the majority of people have preferred to be blind to rather than help alleviate the troubles by recognizing their existence. The terrible struggle for existence is particularly emphasized. Our own conclusions can best be drawn from a notice quoted in the book to the effect that the works were to accept "no more men over forty years of age in any department." The speeding-up system is summed up in the remark that "Over each gang is a foreman who is commonly referred to as the 'pusher,' because his main duty is to 'push' the men, and urge them to keep up a rapid pace." Speaking of the risks incurred by the operatives, Mr. Fitch says: "Men are not recompensed according to the degree of risk involved in their trades." This refutes the commonly accepted idea regarding such matters. The whole work deals most masterfully with the chain of wage cutting, twelve-hour day, seven-day week, abnormal heat conditions, and relentless speeding, bringing these features very prominently into the limelight; very strongly indeed, for Mr. Fitch's remarks are in no wise modified. he has figuratively taken the bull by the horns and painted the conditions in their true light—not through rose-colored glasses. The book is worthy of careful study.

HOMESTEAD; THE HOUSEHOLDS OF A MILL TOWN. By Margaret F. Byington, edited by Paul N. Kellogg. 292 pages, 6 x 9 inches. Illustrated. Published by the Charities Publication Committee, New York, under the Russell Sage Foundation. Price $1.50; postage, 20 cents extra.

One often hears in a vague way, through the newspapers or similar sources, about the industrial conditions that exist in the Pittsburg district, but it has remained for this book to point out—not in a brief, superficial manner, but after a year's study by the author—the conditions as they actually exist. The stupendous character of the work undertaken, which is one of a series of six, called The Pittsburg Survey, can best be appreciated by a study of the book. Miss Byington, who was well-known as a scientific charitable worker in Boston and New York previous to taking up this important study, has devoted the best part of a year to gathering data for this work, and the conclusions drawn can best be realized by quoting her single-sentence summary to the effect that the toilers "turn daily from twelve hours in the din of the huge mills to home, supper, a smoke and bed." In her investigations, a complete and authentic interpretation of the household end of the wage problem was obtained, the facts being based on the expenditures of ninety families, representing every nationality and wage group among the mill town people. Data showing the relation of cost of living to wages in both hard and good times are the outcome of this wage study. In the investigation, Miss Byington found that the mill towns are divided into two great groups—the English-speaking, including Northern European as well as native Americans, and on the

other hand, the Southern European races. These two great classes are in a state of antipathy, thus hindering the solution of the great American problem—the assimilation of the hordes of foreigners. This is still further hampered by these classes segregating into racial and religious groups. The testimony offered in the book does not speak very favorably for the working conditions, which tend to disrupt the home, the length of working hours keeping the men away from it except for the plain necessities of eating and sleeping. The book is significant in representing the conditions at the end of what has been one of the most prosperous decades on record. When conditions are as terrible as those depicted—conditions which can only be realized by a perusal of the book—the question naturally arises, "What would become of the district should a prolonged period of hard times develop?" The book emphasizes the tremendous problem confronting the American commonwealth.

POPULAR HANDBOOK FOR CEMENT AND CONCRETE USERS. By Myron H. Lewis and Albert H. Chandler. 430 pages, 6 x 9 inches. 126 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.50.

This book has been introduced into a field already pretty well supplied with technical literature because of a belief on the part of the publishers that nothing heretofore published has filled the want of a semi-popular book of the general type. The objection to the existing books is that they are either too technical and based on unproved theories, or else that they are too general, and contain no data that would be available to an engineer who desired to design a cement and concrete structure from the information at hand. The authors of this book have succeeded in providing a text-book intelligible to all who have a slight knowledge of the subject. Not only are the principles explained, but there is also much specific cost data based on reliable information gleaned from various sources, principal among which are the leading civil and concrete technical papers. To the mechanical engineer, the book is of interest, containing several chapters on reinforced concrete building construction. The chapters are as follows: Introductory; Kinds of Cement and How They are Made; Properties, Testing, and Requirements of Hydraulic Cements; Concrete and Its Properties; Sand, Broken Stone, and Gravel for Concrete; How to Proportion the Materials; How to Mix and Place Concrete; Forms for Concrete Construction; The Architectural and Artistic Possibilities of Concrete; Concrete Residences; Mortars, Plasters, and Stuccos, and How to Use Them; The Artistic Treatment of Concrete Surfaces; Concrete Building Blocks; The Making of Ornamental Concrete; Concrete Pipes, Fence Posts, etc.; Essential Features and Advantages of Reinforced Concrete; How to Design Reinforced Concrete Beams, Slabs, and Columns; Explanation of the Theory of the Design of Reinforced Concrete Beams and Slabs; Systems of Reinforcement Employed; Reinforced Concrete in Factory and General Office Construction; Concrete in Foundation Work; Concrete Retaining Walls, Abutments, and Bulkheads; Concrete Arches and Arched Bridges; Concrete Beam and Girder Bridges; Concrete in Sewerage and Drainage Works; Concrete Tanks, Dams, and Reservoirs; Concrete Sidewalks, Curbs, and Pavements; Concrete in Railroad Construction; The Utility of Concrete on the Farm; The Waterproofing of Concrete Structures; Front or "Liquid Concrete" and Its Uses; Inspection of Concrete Work—A Summary of Essential Rules and Principles of Construction for Securing Good Concrete Work; and Cost of Concrete Work.

CATALOGUES AND CIRCULARS

CROCKER-WHEELER CO., Ampere, N. J. Small hanger illustrating the Remek transformer.

E. G. SMITH, 134 N. 3rd St., Columbia, Pa. Leaflet bulletin No. 28 describing the Columbia caliper, No. 2.

AMERICAN SPIRAL PIPE WORKS, Chicago, Ill. A four-page pamphlet giving illustrations of some of the lap-welded steel pipe made by this company.

WILLIAMSON FREE SCHOOL OF MECHANICAL TRADES, Williamson School P.O., Delaware Co., Pa. Bulletin No. 7 describing the shop course in bricklaying.

WASHBURN SHOPS, Worcester, Mass. The Worcester drawing stands made in the Washburn shops of the Worcester Polytechnic Institute are described in catalogue F.

BRISTOL CO., Waterbury, Conn. Bulletin No. 127 describing Bristol's Class 3 recording thermometers which have ranges of temperature from 60 degrees below zero to 800 degrees F.

CINCINNATI GASKET & PACKING CO., 1536-1538 Plum St., Cincinnati, Ohio. Catalogue and circulars describing and giving dimensions of gaskets and packing made by this company.

COLLINS AXLE MFG. CO., 319 Frick Bldg., Pittsburg, Pa. Four page bulletin, describing the direct-drive axles made by this company. Data of tests made on these axles are included.

STANDARD GAUGE STEEL CO., Beaver Falls, Pa. A little booklet published by this concern gives the prices and shapes of steel bars for the cold drawn shafting which the company has recently put on the market.

PENNSYLVANIA RAILROAD CO., Philadelphia, Pa. A pamphlet No. G-40 entitled, "Hints on First Aid to the Injured," which is supplemental to some lectures delivered to the employes by the medical examiners of the relief department.

HARRIMAN BROS., 53 State St., Boston, Mass. A booklet gotten out by this firm is probably one of the first of a new line which is gradually developing. It describes the new Harriman type of aeromobile and aerocar.

NEW ENGLAND LINES, South Station, Boston, Mass., have issued a forty-page pamphlet entitled, "Remaking a Railway; A Study in Efficiency," written by Sylvester Baxter. It deals with the new transportation epoch in New England.

WILLIAMS TOOL CO., Erie, Pa. This company has published two pamphlets on the transverse current feed water heater in its application to the gas engine and to the steam engine. The constructional features are not dealt with to any great extent.

GARVIN MACHINE CO., Spring and Varick Sts., New York City, has published a large wall poster containing the decimal equivalents in very prominent type for reference purposes. This should prove useful in the drawing-room, ⅝-inch type being used.

NATIONAL SEWING MACHINE CO., Belvidere, Ill. Catalogue of automatic screw machines with illustrations and descriptions of machines, tools, attachments and products. It is well illustrated and should be of interest to automatic screw machine operators.

ADAMS CO., 850 White St., Dubuque, Iowa. Circular No. 805 is a new complete pamphlet on the Farwell gear hobber, covering both the Nos. 1 and 3 sizes. The pamphlet explains at some length the method of producing gears by the hobbing process, detailing the advantages.

THOMAS H. DALLETT CO., York and 23rd Sts., Philadelphia, Pa. This firm which manufactures air compressors has issued three new bulletins: No. 200, General Construction Details; No. 201, Straight Line Belt-driven Machines; No. 202, Straight Line Steam-driven Machines.

CARLYLE JOHNSON MACHINE CO., Manchester, Conn. In this neat catalogue E, the Johnson friction clutch is dealt with in a clear concise manner. Several auxiliary appliances used in connection with the clutch are also described, and of all these parts the standard dimensions are given.

HANNA ENGINEERING WORKS, 2059 Elston Ave., Chicago, successor to the Electric Machinery Sales Co., Milwaukee, Wis. Bulletins Nos. R 1 and R 2 on the Ajax electric riveting machines of the bench, pedestal, portable and "holder-on" types and the semi-portable-yoke and "holder-on" types.

VANADIUM SALES COMPANY OF AMERICA, Frick Bldg., Pittsburg, Pa. The first issue of *American Vanadium Facts*, the new house organ of this company, made its first appearance in March. It is a bright little publication which will be published periodically in the interests of "Amervan" ferro-vanadium.

COOPER HEWITT ELECTRIC CO., Eighth and Grand Sts., Hoboken, N. J. Bulletin No. 36 superseding bulletin No. 23, describes the Cooper Hewitt electric lamps, type P, direct current, for indoor service. Another pamphlet entitled, "Better than Day-Light," deals with the advantages accruing from the use of this means of illumination.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Bulletin 1120, Type A Electric Rock Drill; No. 1122, Small Motors and their Applications; No. 1123, Single-Phase Prepayment Induction Watthour Meter; No. 1126, Fort Wayne Electric Fans. This latter is a fine example of the printer's art. An index for bulletins Nos. 1001 to 1125 has also been prepared.

LUCAS MACHINE TOOL CO., Cleveland, Ohio, has just issued a circular No. F-5 describing the new model No. 32 "precision" horizontal, boring, drilling and milling machine. This model has quick power movements to all parts, having feeds so arranged that no matter what feed is used the quick return is obtained by simply moving the "feed and quick return lever."

GARDNER MACHINE CO., Beloit, Wis. Gardner disk grinding machinery and accessories are described in this latest catalogue, all the different sizes of machines being listed, giving their general characteristics and dimensions. The general constructional features are described and the application of the machine to different classes of work illustrated with a number of photographs.

GENERAL ELECTRIC CO., Schenectady, N. Y. "Motor Drive for Metal Working Machinery," is the title of bulletin No. 4815 superseding No. 4548. In this catalogue the general application of electric motor drive for metal working machines is illustrated very completely, practically every type of machine tool being shown in its adaptation to this means of drive. It might well be considered a text on the subject.

MICHIGAN TWIST DRILL CO., Detroit, Mich. Circular of "Michigan" hot forged twist drills made of carbon and "Novo" high-speed steel, comprising straight and taper shank drills, jobbers' drills, taper square shank drills fitting ratchets, Coes' drills, Silver and Deming drills, wood boring brace drills, bit stock drills, etc.; also fluted shell reamers, rose shell reamers, taper reamers, three-groove chucking reamers and solid or hand reamers.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. The different types of rivet heating furnaces which this company manufactures are described in bulletin No. 227; brief illustrated descriptions are also given of their other miscellaneous furnaces. Bulletin T describing the Moyer tramrail in modern foundry practice has for its main feature a paper on this subject presented by Mr. Moyer before the American Foundrymen Association, June, 1910.

LANDIS TOOL CO., Waynesboro, Pa. The 1911 catalogue on grinding machines for cylindrical and conical surfaces is a fine sample of catalogue printing, being handsomely made up. In addition to the numerous illustrations of machines manufactured, there are several illustrations showing specific uses to which the machine can be advantageously put. Valuable grinding data are also included which should be in the hands of grinding operators generally.

CROCKER-WHEELER CO., Ampere, N. J. Polyphase induction motors, constant speed, 60 cycle, with horsepowers varying from ½ to 250, are described in bulletin No. 126, which supersedes former bulletin No. 115. Numerous applications of these motors are included. An interesting pamphlet entitled, "Should Terms of Payment be Enforced?" written by the treasurer of the company, Mr. W. L. Brownell, which was presented before a meeting of the National Association of Credit Men has been published

CHICAGO MACHINE TOOL CO., 127 N. Canal St., Chicago, Ill. General catalogue of the Chicago milling machines comprising a variety of styles of equipment of the bench and column type machines, ranging from a bench machine weighing 235 pounds to a column type machine with overhanging arm, automatic feed, etc., weighing 990 pounds. The style with vertical spindle attachment offers the manufacturer a machine embodying both horizontal and vertical spindles, economically adaptable to a great variety of manufacturing operations.

JACOBS MFG. CO., Hartford, Conn., has just issued an attractive and comprehensive catalogue of the Jacobs improved drill chucks, showing half-tone illustrations—actual size—of the ten different sizes and forms of Jacobs drill chucks manufactured. The Jacobs chuck is operated by a wrench carrying a toothed pinion which engages teeth cut in the sleeve. The advantage of this construction is that there is no tendency to turn the spindle when tightening or loosening the chuck jaws. The catalogue will be mailed free to any one requesting it.

SHORE INSTRUMENT & MFG. CO., 555-557 West 22nd St., New York. Catalogue and treatise on the Shore scleroscope, an instrument for testing the hardness of metals by measuring the rebound of a small falling weight. This interesting device is described and illustrations of its use are given. It is employed to measure the hardness of metals and to determine generally the characteristics of metals before and after hardening, and of alloys, which have an important influence on the manufacturing operations or the finished product. Seldom does a piece of trade literature contain the valuable information to be found in this treatise.

FOOS GAS ENGINE CO., Springfield, Ohio. Catalogue No. 23 illustrating and describing the Foos horizontal single-cylinder gas engine built in sizes from 3 to 90 H.P.; also the new Foos oil engine designed for operation on kerosene and other heavy liquid fuels. A few shop views are included showing typical machining operations on Foos engines, of general interest. The remarkable stability of the horizontal engine is illustrated by a view showing a test in which the engine was mounted on polished steel rollers resting on two I-beams. A photograph was taken of the engine running at full speed and no vibration of the frame is indicated in the picture.

BAYONNE CASTING CO., Bayonne, N. J. Booklet on monel metal, brass, bronze and other alloys. The booklet treats of monel metal, forms in which it is sold; its uses; adaptability for castings, rods, sheets, forgings; physical properties; government specifications, etc. Monel metal is a natural alloy containing approximately 67 per cent nickel, 27 per cent copper and 6 per cent of other metals, principally iron and manganese. In appearance it cannot be distinguished from pure nickel and its great strength and extreme incorrodibility admirably adapt it for use in marine work and engineering construction, for parts that come in contact with salt water and for valves and fittings that are subjected to superheated steam.

CONTENTS FOR APRIL

The first column of page numbers applies to the Engineering and Railway Editions; the Second to the Shop Edition.

TRADE NOTES

West Haven Mfg. Co., West Haven, Conn., maker of hack saws, was burned out March 8.

J. Wyke & Co., East Boston, Mass., have gone out of business. The future address of Mr. Wyke will be South St., Wilmington, Mass.

Union Caliper Co., manufacturer of small tools, has moved from Fitchburg, Mass., to Orange, Mass., where a factory building has been bought. The company will enlarge its business and add to its present line of manufacture.

Bosch Magneto Co., New York, has completed its large reinforced concrete factory building at Springfield, Mass., and is installing machinery. The company will begin manufacturing magnetos in the new plant early in April.

Standard Gauge Steel Co., Beaver Falls, Pa., has completed a large new plant which greatly increases its capacity. The company has taken on a new line consisting of cold rolled and finished shafting, screw stock and rounds.

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y., has built a four-story addition of concrete construction to its factory, which will materially add to the facilities now on hand for handling the company's die-casting business.

General Electric Co., Schenectady, N. Y., has recently obtained an order for 60 two-motor 70 H. P. cars for the Detroit United Railways of Detroit, Mich. The Northern Ohio Traction Co., of Akron Ohio, has also placed a large order for new equipment with the company.

Joseph Dixon Crucible Co., Jersey City, N. J., states that it supplied graphite and graphite lubricants to 210 steam roads during 1910, showing an increase of 53 per cent. The same lubricants were sold to 91 automobile manufacturers, showing a business increase of 260 per cent.

Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill., has made a contract with the Electric Machinery Sales Co., of Milwaukee, Wis., to succeed it as general sales agents for the Ajax electric riveting machines, including the Ajax yoke riveter, the first line of light yoke riveters offered to the trade.

Pawling & Harnischfeger Co., Milwaukee, Wis., crane builder, at a recent meeting of its board of directors elected S. H. Squier director and secretary; W. H. Hassenplug, sales manager, was elected a director and second vice-president; and F. P. Breck, associated with the company for many years, was elected a director.

Institute of Operating Engineers, 29 W. 39th St., New York, formed a new branch at Yazoo City, Miss., called "Col. Goethal's branch, No. 1," on January 28. F. C. Holly is branch chairman, and L. B. Smith, secretary-treasurer. The address of the secretary and treasurer is P. O. Box 297, Yazoo City, Miss.

Richardson-Phenix Co., Milwaukee, Wis., has recently opened a branch office in the Keystone Building, 324 Fourth Avenue, Pittsburg, to care for its constantly increasing business in the Pittsburg district. The office will be under the management of Mr. H. M. Laughlin, who has been with the Richardson-Phenix Co. for several years.

Westinghouse Machine Co., Pittsburg, Pa., has recently obtained an order for two 3750 K. W. steam turbines for the Northern Indiana Gas and Electric Co. of Chesterton, Ill. The turbines will operate with a steam pressure of 175 pounds, with 100 degrees superheat, exhausting into 28 inch vacuum, and will be connected to Westinghouse generators.

Grand Rapids Machine Tool Co., Grand Rapids, Mich., has been incorporated with $20,000 capital, $10,000 of which is subscribed and paid in. The officers are Matthew Lund, president; J. F. Nellist, vice-president; and G. C. Mason, secretary and treasurer. The company manufactures plain milling machines and no further equipment will be added now.

Reed Mfg. Co., Erie, Pa., manufacturer of machinists' vises and steam fitters' tools, has just completed a large three-story addition to its factory which increases the capacity 80 per cent. The equipment is modern in every respect. The company's business has grown very rapidly, its records showing a net increase each month for over twenty-four months.

American Motor Truck Co., Findlay, Ohio, announces the consolidation of the Lockport Stamping Co., the Findlay Motor Co., and the American Motor Truck Co. The Lockport Stamping Co. and the American Motor Truck Co. are being moved from Lockport, N. Y., to Findlay, where the executive offices of the consolidated concerns will be located also.

Lester & Wasley Co., Inc., Norwich, Conn., has been incorporated to manufacture "Leader" envelope machines, and other light machinery, with a capital of $25,000. The incorporators and directors are: Frederic W. Lester, president; H. L. Stanton, vice-president; Percival W. Chapman, treasurer; Franklin H. Allen, secretary; and George W. Armstrong, superintendent.

Bowman-Blackman Machine Tool Co., 720 N. Second St., St. Louis, Mo., is the successor of Albert B. Bowman, dealer in machine shop equipment. The change is due to the entrance into the firm of Mr. G. H. Blackman, a graduate of the mechanical department of the Missouri State University and an experienced machine tool man. He has been with the Bowman concern for several years.

Ahrens Iron Works Co., Cincinnati, Ohio, is a new corporation which succeeds the Union Iron Works Co. of that city. The new company has been regularly chartered under the laws of the state of Ohio and the business will be conducted in the modern and extensive plant recently constructed by the Union Iron Works Co. The business is the manufacture of structural and ornamental steel and iron work.

Manheim Mfg. & Belting Co., Manheim, Pa., is a new company which has recently been formed. The officers are: Chas. Bond, president; George H. Danner, vice-president; M. M. Pfautz, secretary; and M. G. Hess, treasurer. The principal object of this company is to manufacture Veelos Balata belting, a product which has up to the present time been imported by the Chas. Bond Co. of Philadelphia, Pa.

Reliance Electric & Engineering Co., Cleveland, Ohio, has removed to its new offices and shops on Ivanhoe Road. The new plant is of reinforced concrete construction with saw-tooth roof and other features of the modern up-to-date manufacturing plant. The company manufactures the Reliance alternating-current and direct-current motors and direct-current adjustable-speed motors, which latter are being used advantageously for machine tool driving in combination with simple mechanical changes.

Wilmington Institute Free Library, Wilmington, Del., is making a special effort to develop its department of applied science. The circulation of technical books used by the working men of the city has increased nearly 200 per cent in five years. The department has been seriously handicapped in not having the trade catalogues of the various manufacturing concerns throughout the country and the librarian requests that manufacturers send their catalogues to the library. Any trade catalogue published in the country will be valued.

Yale & Towne Mfg. Co., 9 Murray St., New York City, has been awarded the contract for installing a complete monorail overhead tramway system for the J. H. Ladew Co.'s new large tannery, Plank Road and Passaic River, Newark, N. J. The equipment comprises about three-quarters of a mile of I-beam, three traveling cranes, transfer devices, automatic fire-door attachments, etc., and is notable as showing the tendency toward overhead or "aerial" transportation for the handling of materials in up-to-date manufacturing establishments.

Buffalo Forge Co., Buffalo, N. Y., reports that the New Jersey Zinc Co. has recently placed an order for fifty-four large special fans. These fans were purchased after a competitive trial of several makes under identical conditions. The saving of power effected in the

Buffalo fan is attributed to the accuracy with which the dimensions of the inlet, outlet, length of blades, diameter of wheel, width, etc., were proportioned to meet the special conditions. The importance of the order can be inferred from the fact that it will make up over eight carloads.

STERLING MACHINE CO., Norwich, Conn., is the new name of the concern resulting from the purchase, by the Uncas Specialty Co. of Norwich, of the Rochester Machine Tool Co. and the Sterling Lubricator Co., both of Rochester, N. Y. The capital stock of the Uncas Specialty Co. was increased from $50,000 to $100,000 and the name was changed as given above. Both the Rochester Machine Tool Co. and the Sterling Lubricator Co. will be moved to Norwich, where facilities will be afforded for increasing their product, which is automatic lubricators and motor parts.

THADDEUS STEVENS INDUSTRIAL SCHOOL, Lancaster, Pa., is an industrial educational institution founded by the late Thaddeus Stevens and supported by his bequests and the State of Pennsylvania. The pupils are boarded, clothed and instructed free of charge. Other things being equal, preference in admission will be given to indigent orphans and poor boys at large. The school is now engaged in teaching bricklaying, carpentery, patternmaking and the machine trade. Boys to be admitted must be between sixteen and eighteen years old, have a common school education, be of good moral character and reside in the State of Pennsylvania.

BUREAU OF NATIONAL INDUSTRIES, 11 Broadway, New York City, announces that under its auspices an exhibition of machinery will be held at the Bush Terminal, New York, September 1 to December 1, 1911. The exhibition space will be free to American manufacturers, and allotment of space will be made in order of application for same. The Bush Terminal, where the exhibition will be held, is in a sense the union freight terminal of all the trunk railroads entering New York and Jersey City, and is also the docking place of sixteen steamship companies. The floor space of the exhibition building is 123,000 square feet. Further information may be obtained upon application to the Bureau.

H. W. JOHNS-MANVILLE CO., 100 William St., New York City, announces that it is now offering to the trade a line of cements which are rated to resist temperatures as high as 3000 degrees F. They are intended for furnace settings of various types, cupolas, lining brass furnaces, assayers' crucibles, tilting and rotary furnaces, and for patching and facing blocks in place in the fire zone under various conditions. They are called "J.-M refractory cements." The discovery is the outcome of several years devoted to research work on refractory cements to overcome any troubles experienced on this score. Their advent may be considered a forward step in the efficient maintenance of high temperature furnaces.

SIMONDS MFG. CO., Fitchburg, Mass., announces that its new steel mill at Lockport, N. Y., is now in operation, the first steel being rolled on January 2. This new plant was necessitated by the very limited space in the steel mill of the Chicago plant; work on the new plant was therefore begun early last summer. Gas for the plant is generated in a modern gas producing plant adjacent to the crucible furnace building. There is a separate rolling mill for band, crosscut and circular saw plates, and in addition, provision is made for hand saw plates and steel specialties. A general building at the end of the rolling mill is provided for the making of steel ingots. A building at the entrance to the plant accommodates the office and laboratory forces.

NATIONAL METAL TRADES ASSOCIATION. At the recent annual meeting of the Worcester, Mass., branch of the association, Charles H. Norton, chairman of the Worcester Labor Bureau, reported that during the past year there had been 10,784 applications for employment. During the same period the shops have reported 3571 men and women hired. Donald Tullock reported among other things that three of the pioneers in the metal trades, all of whom were members of the branch, had passed away during the year. They are Hon. E. T. Marble, president of the Curtis & Marble Machine Co.; Charles H. Morgan, president of the Morgan Construction Co.; and Dexter Harrington, president of the Harrington Cutlery Co., of Southbridge. The officers for the ensuing year are: President, A. E. Newton, Prentice Bros. Co.; vice-president, John W. Higgins, Worcester Pressed Steel Co.; treasurer, A. W. Beaman, Stockbridge Machine Co.